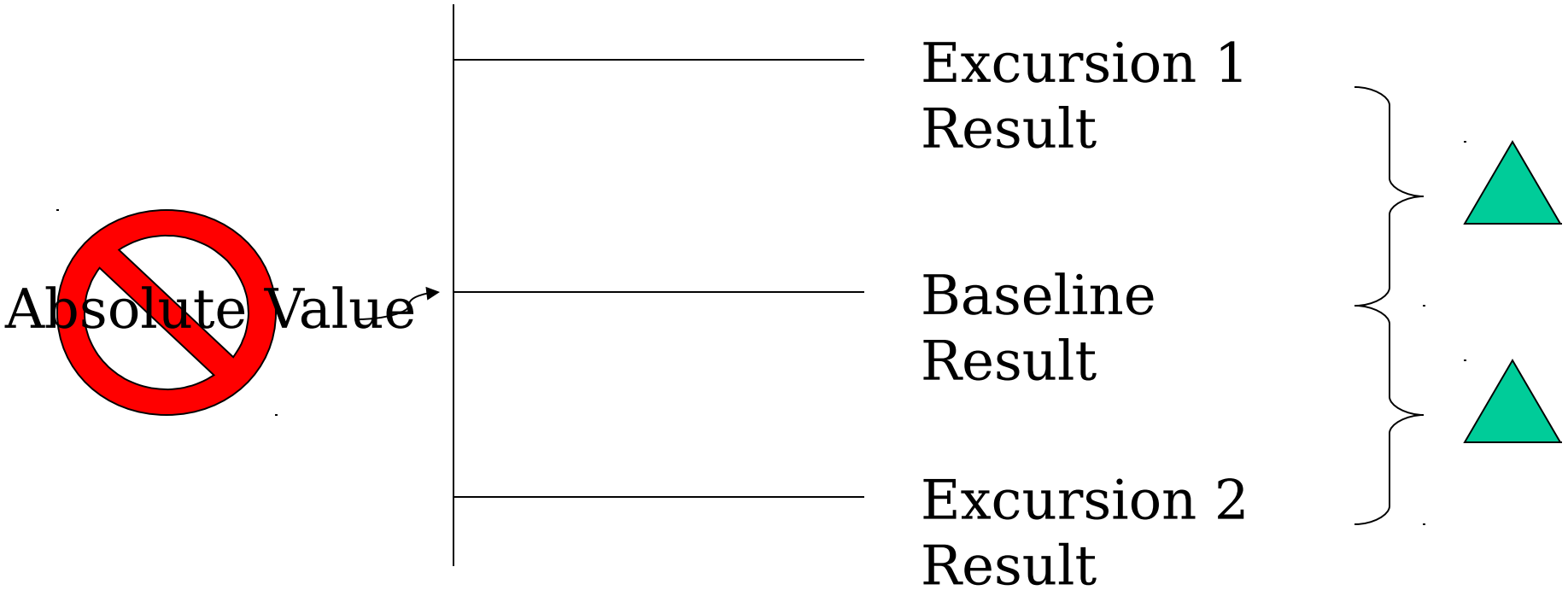
World Class Modeling Initiative

OPNAV N816

31 March 2004

Baseline & Excursion Methodology



M&S does not produce absolute truth

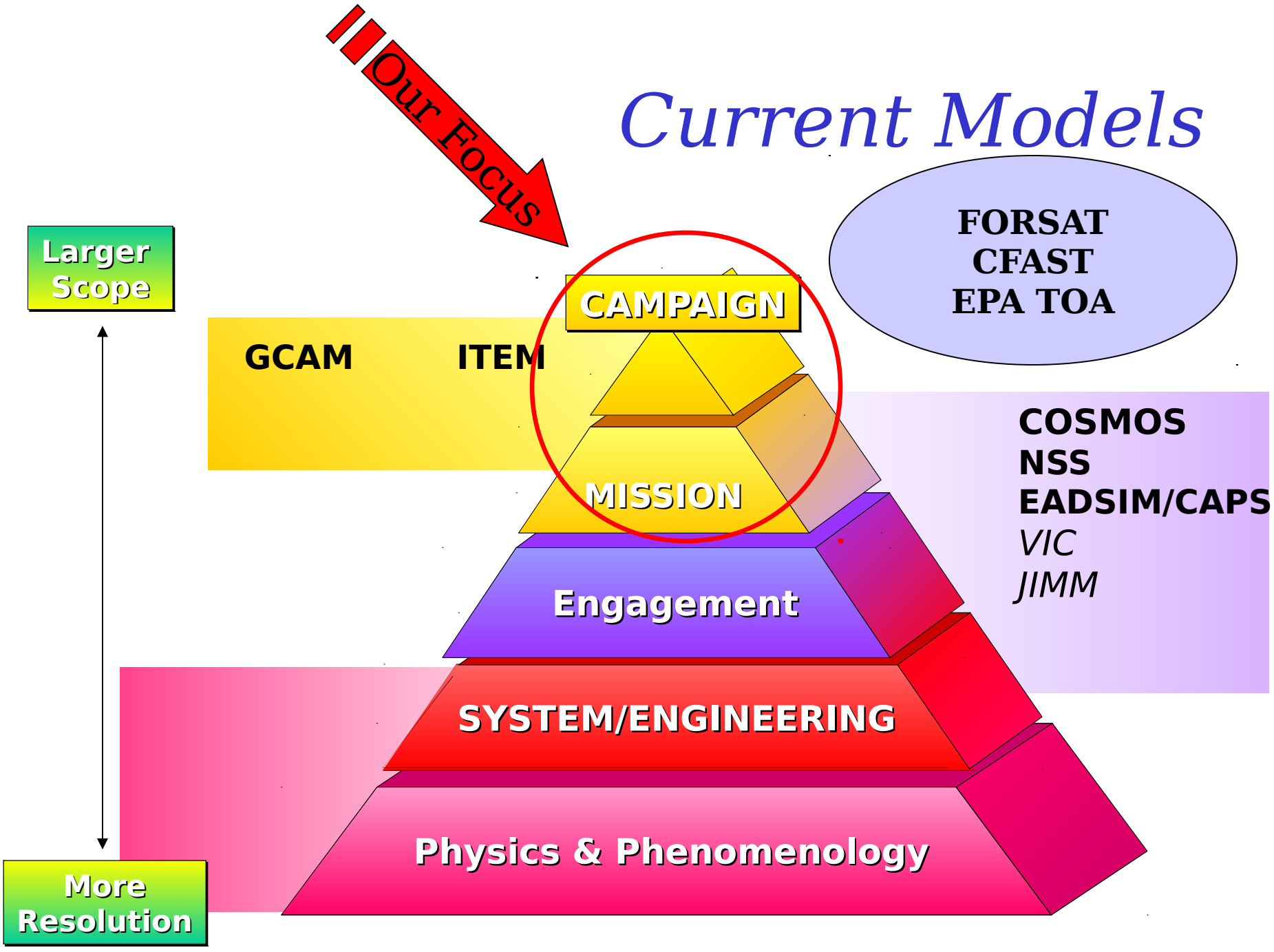
Relative Changes produce insight to answer questions

Metrics
Measurable – Quantifiable - Applicable

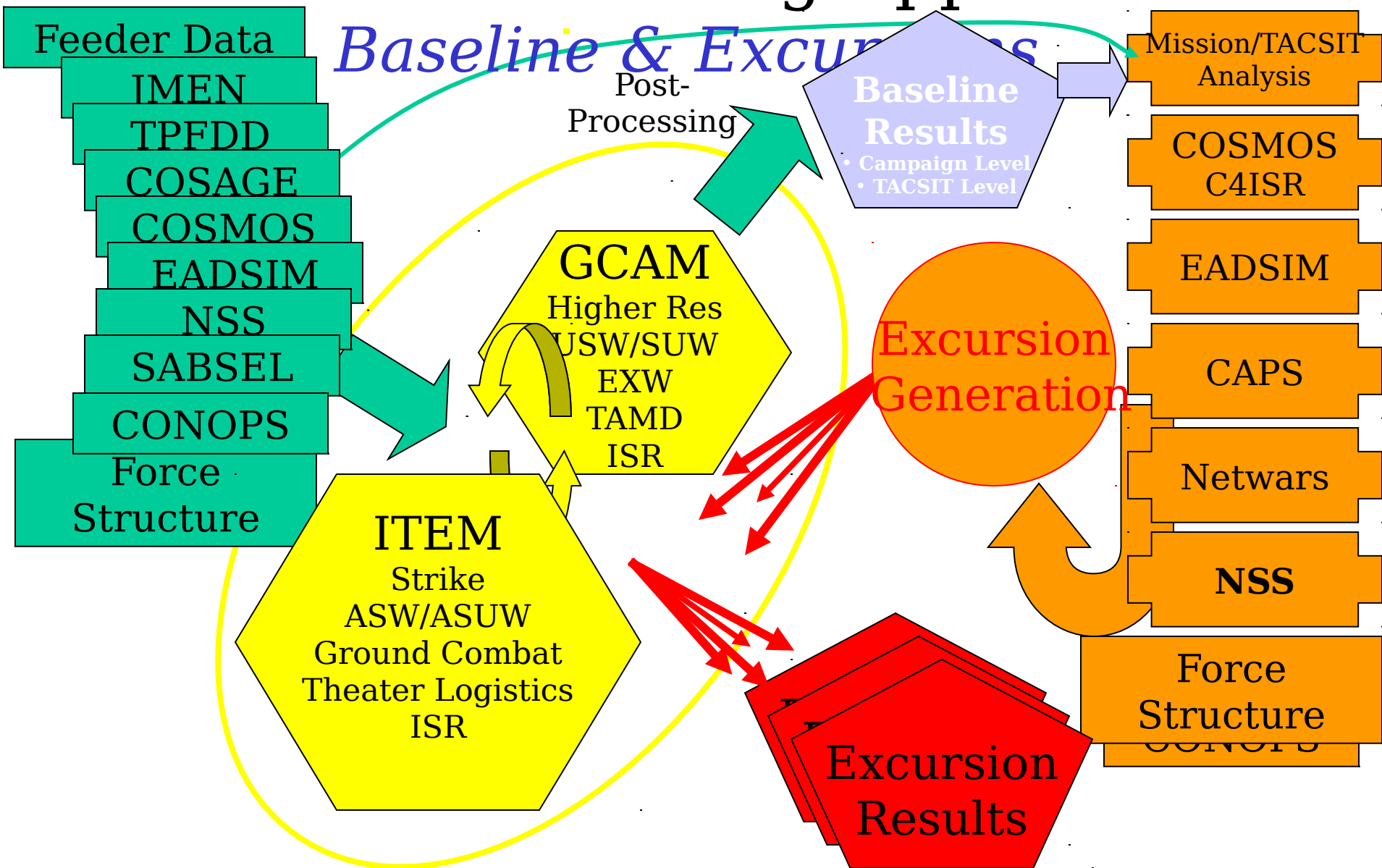
- Number or percentage of enemy targets destroyed
- Number or percentage of strike sorties flown
- Number or percentage of strike aircraft lost
- Number of weapons expended
- Impact of destroying some of the targets would be measured in other warfare areas through fewer losses

Just because it is easy to measure does not make it worth measuring

Current Models



Current Modeling Approach



	Strike				Naval Fire Support			STOM			Deterrence			
SEA STRIKE	Strike	Special Ops	Offensive IO	Acft Survivability	Precision Fires	High Volume Fires	Extended Range Fir	Project, Reposition	Assault	Concurrent and Fol	Nuclear Strike	Assured Survivabilit		
MCO-3 2012	Hi				Hi		Hi	Hi	Hi	Hi				
MCO-2 2020	Lo							Lo						

	Force Protection		Surface Warfare		Under Sea Warfare						TAMD			
SEA SHIELD	SOF/Terrorists	Mitigate CBRNE Ef	Self Defense	Offensive Ops	Self Defense	ASW in Littorals	ASW in Open Ocear	MCM (Deep to Shal	MCM (Amphibious	Offensive MIW	Self Defense	Maritime	Overland	Sea Based Missile De
MCO-3 2012			Med-Ex-Hi	Hi	Med	Hi	Lo	Hi	Hi		Lo	Lo	Lo	
MCO-2 2020			Hi	Lo	Hi	Hi	Hi	Hi			Hi	Hi	Hi	Hi

	Deploy and Employ				Provide Integrated Joint Logistics						PREPO		
SEA BASING	Close and Maintain Mc	At-sea Arrival and Ass	Selective Offload	Reconstitue and Regen	Sustainment (at sea)	Sustainment (ashore)	Focused Logistics	Shiboard and Mobile M	Medical Services	Advanced Base Suppor	Integrate / Support Joi	Afloat C2	AFSB Capability for Jo
MCO-3 2012	Hi	Hi		Hi	Hi	Hi	Hi	Hi			Hi		
MCO-2 2020													

	Command Data Network				ISR				COTP					
FORCEnet	Comms Infrastucture	Network Protection	Network Synchronizati	Info Transfer	Sensor Mngmnt and In	Detec and ID Tgts	Cueing and Targeting I	Assess Engagement	Mission Planning	Battle Mngmnt Synch	Common PNT and Em	Integrate and Distribut	Track and Facilitate T	Track and Facilitate N
MCO-3 2012	Exc			Exc	Hi	Hi	Hi	Hi				Hi	Hi	Hi
MCO-2 2020					Hi	Hi	Hi	Hi				Hi	Hi	Hi

OSD & CNO Critical Phenomenon

Capability	Near Term	Mid Term	Far Term
C4	NSS	NSS/NETWARS	Collaborative M&S Framework
ISR	COSMOS Improvements	SLAMEM	Collaborative M&S Framework
Maintenance	Ao Data	Ao Study	Collaborative M&S Framework
WMD	ITEM Module	DTRA Developments	Collaborative M&S Framework

OSD & CNO Critical Phenomenon

Capability	Near Term	Mid Term	Far Term
IO	IO Wargames	NSS/NETWARS	Collaborative M&S Framework
S&T	M&S Work-arounds	NRL Integration	Collaborative M&S Framework
JFEO	ITEM (Rough)	NSS/Combat XXI	Collaborative M&S Framework
FP/AT	SAVAGE	NSS/Combat XXI	Collaborative M&S Framework

OSD & CNO Critical Phenomenon

Capability	Near Term	Mid Term	Far Term
Logistics	TACLOG GCAM/Item improvements		Collaborative M&S Framework
Quick Turn Campaign	JICM		Collaborative M&S Framework

WCM: Overview

Serial	Title World Class Models
WCM-02	Direct Thesis Study - WCM 02
WCM-05	MIW Analysis - WCM 05
WCM-06	Logistician - WCM 06
WCM-07	USAF Expert - WCM 07
WCM-08	USA Expert - WCM 08
WCM-09	Battalion Combat Modeling Module - USA TRAC Monterey
WCM-10	ISR Modeling Using SLAMEM for PR07 -- WCM 10
WCM-11	Upgrade and Use ITEM WMD Module for PR07
WCM-12	Model the effect of Human Factors in the Campaign for PR07 - WCM 12
WCM-13	SOF Modeling (rough) for PR07 - WCM 13
WCM-14	SOF Modeling (Detailed) for PR07 - WCM 13
WCM-15	Joint Forces Entry Option Modeling In Combat XXI for PR07 - WCM 15
WCM-16	Use SAVAGE to Model Force Protection/Anti-Terrorism Modeling for PR97 - WCM 16
WCM-17	Joint Integrated Campaign Model (JICM) Maritime Modeling - WCM 17 Note 1
WCM-18	Improve Strike Module (Rough) in ITEM for PR07- WCM18
WCM-19	Improve Strike Module (Detailed) in Combat XXI for PR07-WCM19
WCM-20	Torpedo Defense Modeling to feed GCAM & NSSS for PR07 - WCM 20
WCM-21	Ship Damage Methodology
WCM-22	Detailed Water Column Data for MC02 & MC03 Spring PR07 - WCM 22
WCM-23	Detailed Weather Data for PR07 - WCM 23

WCM: Overview (cont.)

Serial	Title
	World Class Models
WCM-24	Battle Damage Assessment Modeling for PR07 - WCM 24
WCM-25	Detailed Logistics Modeling for PR07 - WCM 25
WCM-26	Mine Counter Measure Modeling in GCAM for PR07 - WCM 26
WCM-27	Mine Counter Measure Modeling in NSS for PR07 - WCM 27
WCM-28	Analytical Workbench: Tools to improve Analysis - WCM 28
WCM-29	Information Operations Modeling for PR07 - WCM 29
WCM-30	J WARS Support for PR-07 Note 2
	Model Improvements for World Class Modeling
MI-03	GCAM Function Improvements
MI-04	EADSIM Air Defense Data Update
MI-05	Phase II of ITEM upgrades
MI-06	Phase II of GCAM upgrades
MI-07	Internal Database Tool
MI-08	COSMOS Upgrades
WCM-01	Navy Common Database Support - WCM 01

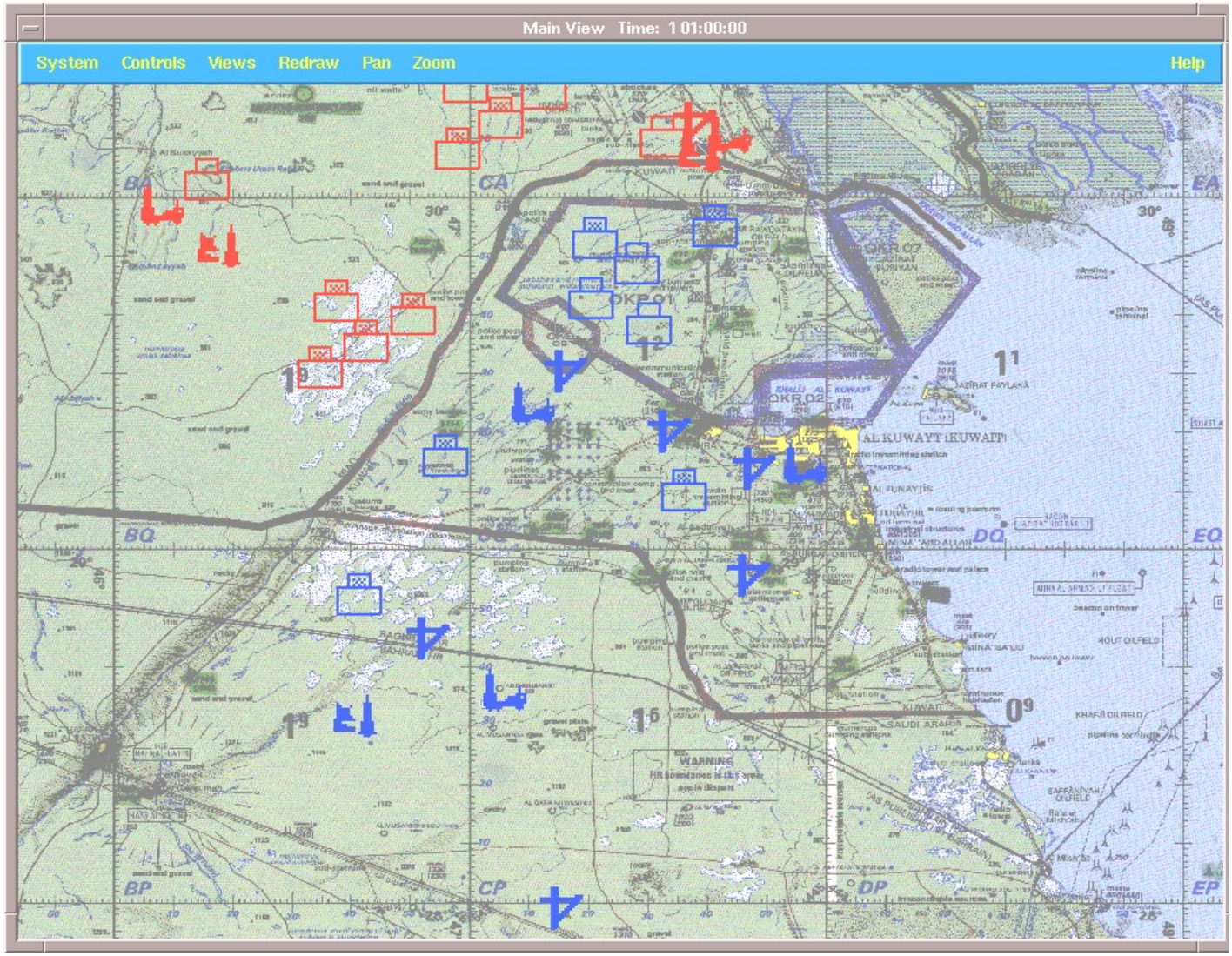
WCM: Overview (cont.)

Serial	Title
	OSD Analytical Agenda
OSJ -01	OSD Analytical Agenda Support - OSJ
OSJ -02	OA-05 MC01 New Baseline Security Posture - OSJ
OSJ -03	OA-06 Foreign International Defense Scenario with New Baseline Security Posture - OSJ
OSJ -04	Homeland defense MSFD & DPS - OSJ
OSJ -05	Strategic Deterrence MSFD & DPS - OSJ
OSJ -06	Joint QDR Input and Preparation - OSJ
	C4ISR/FORCEnet modeling using NSS
OBS-06	SLAMEM for SBR AoA
OBS-05	ICP Quick Turn Analysis support by METRON
OBS-07	PACCOM MCO-2 & MCO-3 2020 Network Centric Warfare
OBS-08	PACCOM MCO-2 & MCO-3 2012 Network Centric Warfare
OBS-09	MCO-1 EXWAR 2020
OBS-10	MCO-1 EXWAR 2005 Current C4ISR Study
OBS-11	MCO-3 2005 Current C4ISR Study
	Operational Availability Data
DAS-01	SPAWAR Support for PR-07
DAS-02	NAVSEA Support for PR-07
DAS-03	NAVAIR Support for PR-07

Note 1: The Joint Integrated Campaign Model (JICM) currently has no Naval Combat modeling but is being adopted by the Joint Staff for Campaign Analysis

Note 2: This effort would continue development of the JWARS model to capture Naval warfare issues while employing the JWARS model in the PRO07 process

ITEM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Views
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WARNING

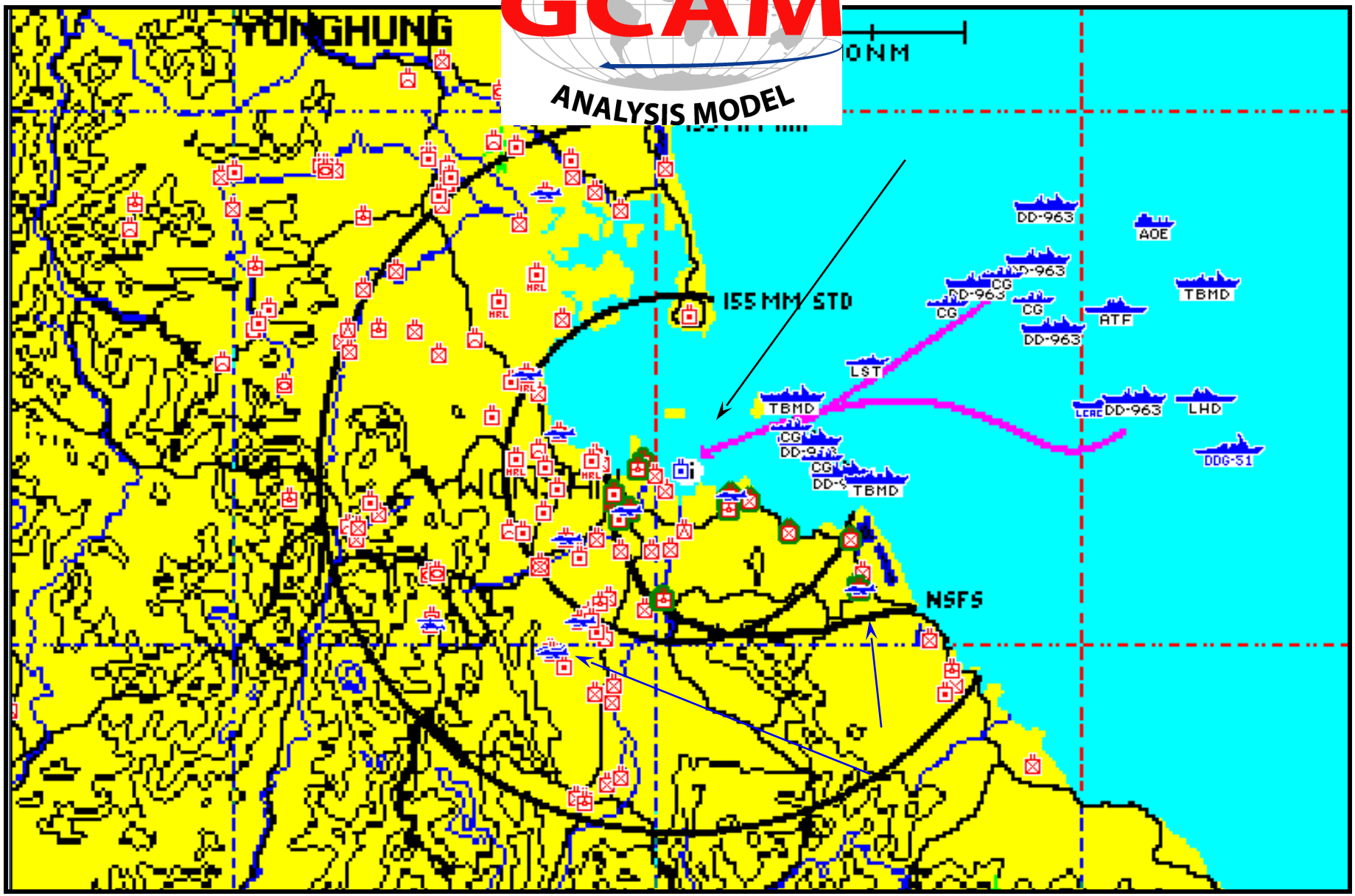
Integrated Theater Engagement Model (ITEM)

- Integrated Theater Combat Model
- Deterministic Score Board Keeper
  - Uses expected values (no dice rolling)
- Scope is the overall Campaign
- C4 Modeling: None
- ISR Modeling: Minimal
  - Targets must be sensed to be attacked
  - ISR sensors place targets in attack queue
- Behavior Modeling: Limited automatic behavior; uses manual intervention by modeler

GENERAL CAMPAIGN

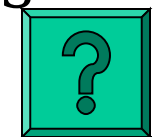
GCAM

ANALYSIS MODEL



General Campaign Analysis Model *(GCAM)*

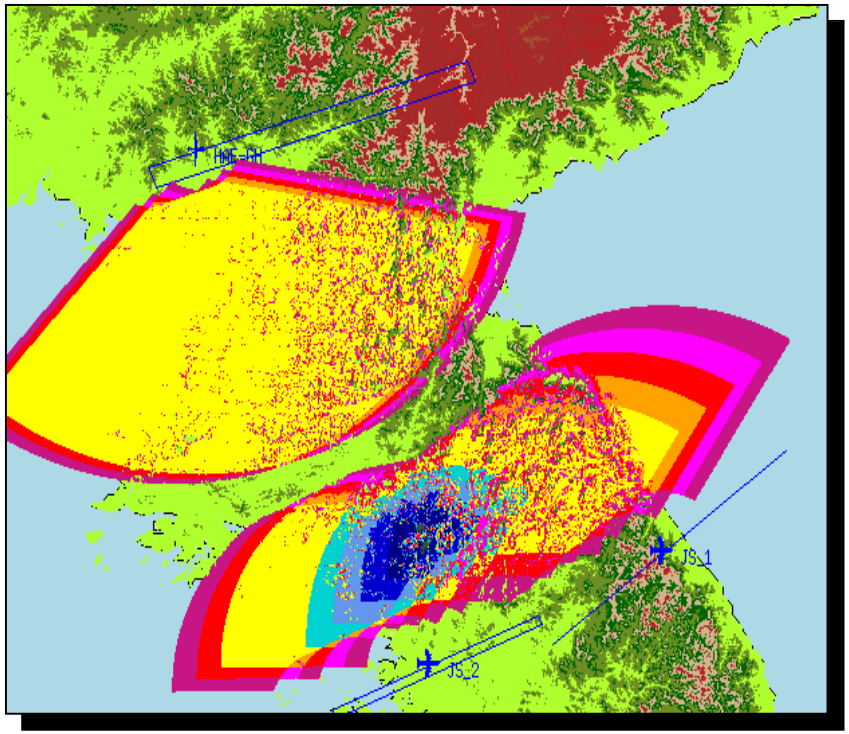
- Integrated Naval Theater Combat Model
- Stochastic Analysis Model
  - Uses data tables to adjudicate interactions (Dice rolled)
- Scope is the overall Naval Campaign with limited ground warfare
- C4 Modeling: Minimal
  - Time delays for messages to trigger commanders and units
- ISR Modeling: Good
  - Targets must be sensed to be attacked
  - Sensors feed commanders that respond based on perception
- Behavior Modeling: Based on Decision Tables

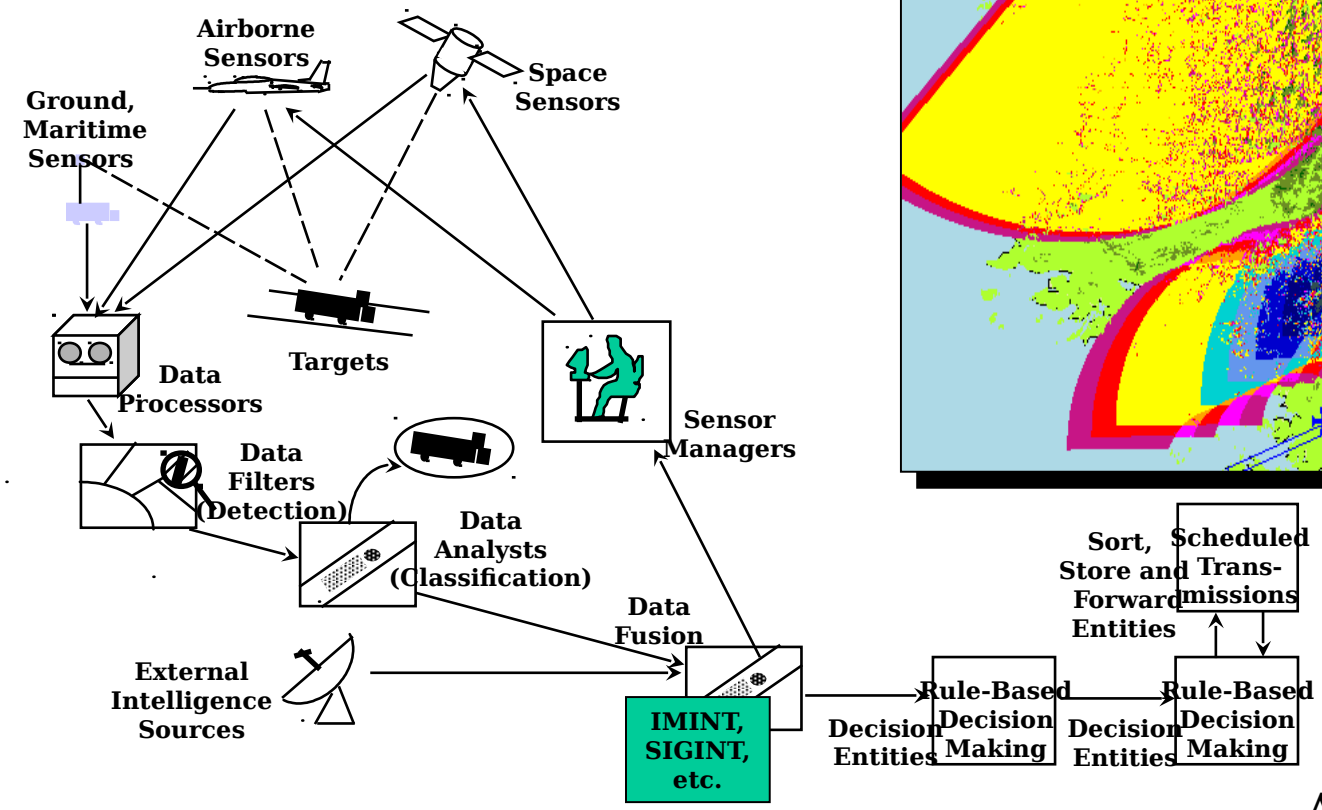


COSMOS

C⁴ISR, Space, & Missile Operations Simulation

- Models ISR assets





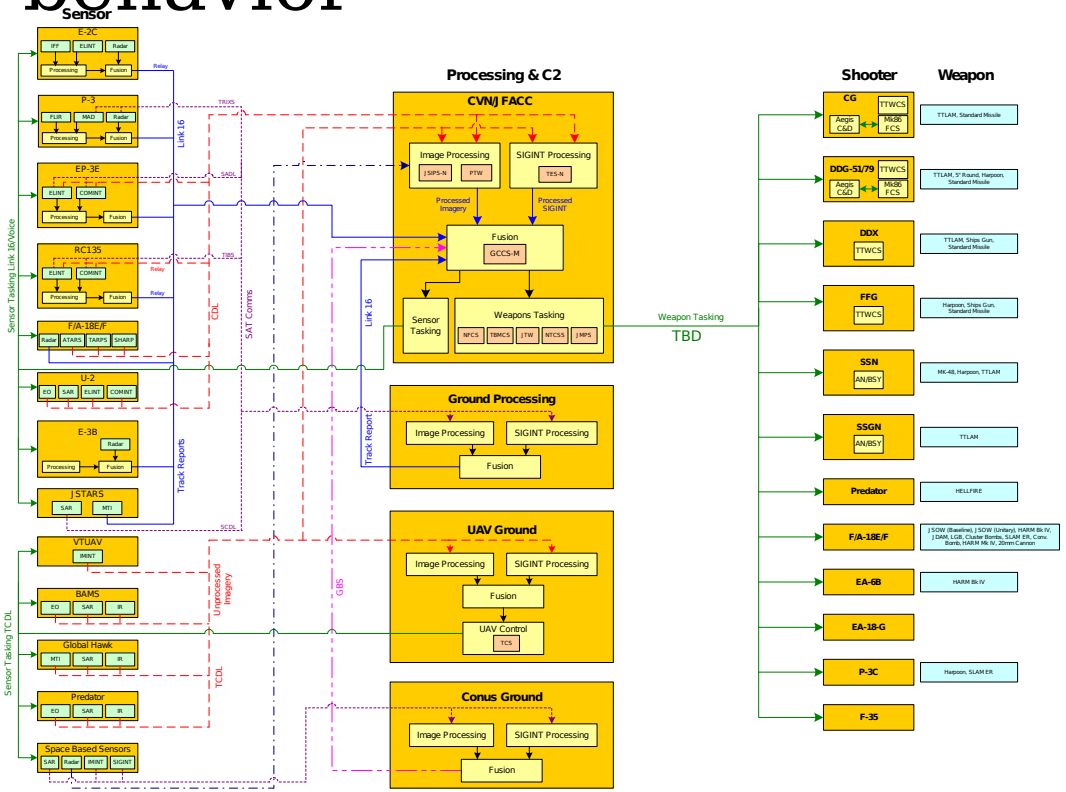
Analysis & Support Division

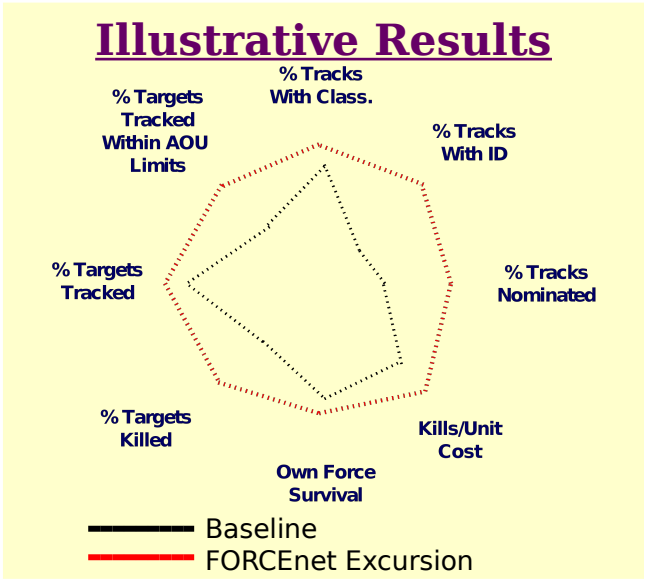
COSMOS
C^4ISR, Space, & Missile Operations Simulation

- Integrated Theater ISR Model
- Stochastic ISR Analysis Model
  - Uses data tables to adjudicate interactions (Dice rolled)
- Scope is the ISR Picture with no assessment of attrition
- C4 Modeling: Some
  - Time delays for messages to trigger follow sensors and report to commanders
- ISR Modeling: Excellent
  - Targets must be sensed to be serviced
  - Sensors feed ISR commanders that respond based on perception
- Behavior Modeling: Based on ISR collection Decision Tables

NSS
Naval Simulation System

- Models sensing, perception, and behavior





Models OODA Loop

Command & Control
- Initial Plans at Force, Mission, and Unit levels
- Responsive Tactics and Forces Re-Direction
- Actions based on CDR's perception of True State

True System State
- Dynamic evolution of all forces locations, status, vulnerabilities
- Interaction effects at the unit and individual platform/weapon level
- Comms at the Message/Net/Link Level among units and facilities

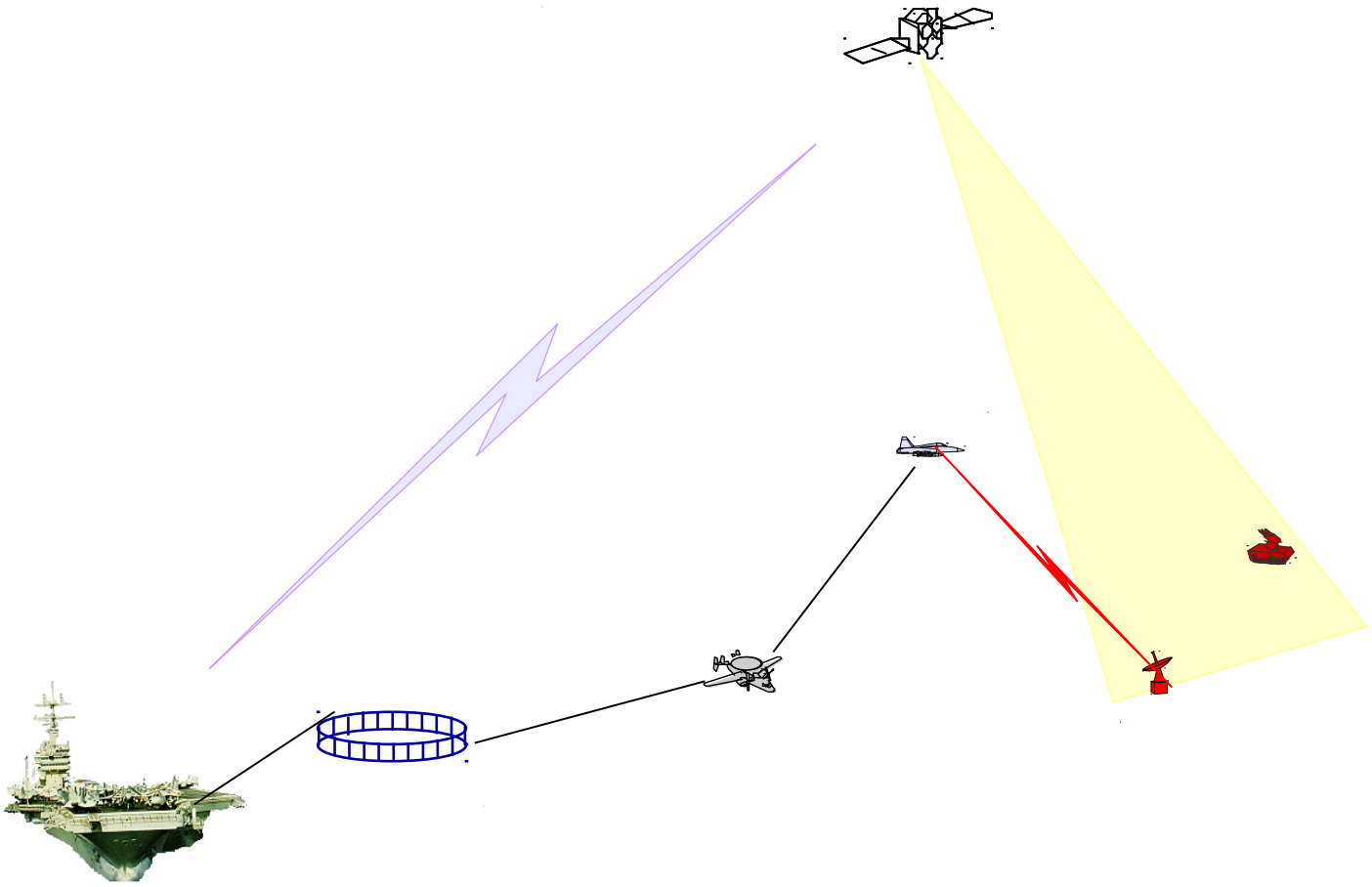
Tactical Picture
- Data Fusion and Tracking algorithms, with BDA
- Picture generated based on received information – can vary with command and platform

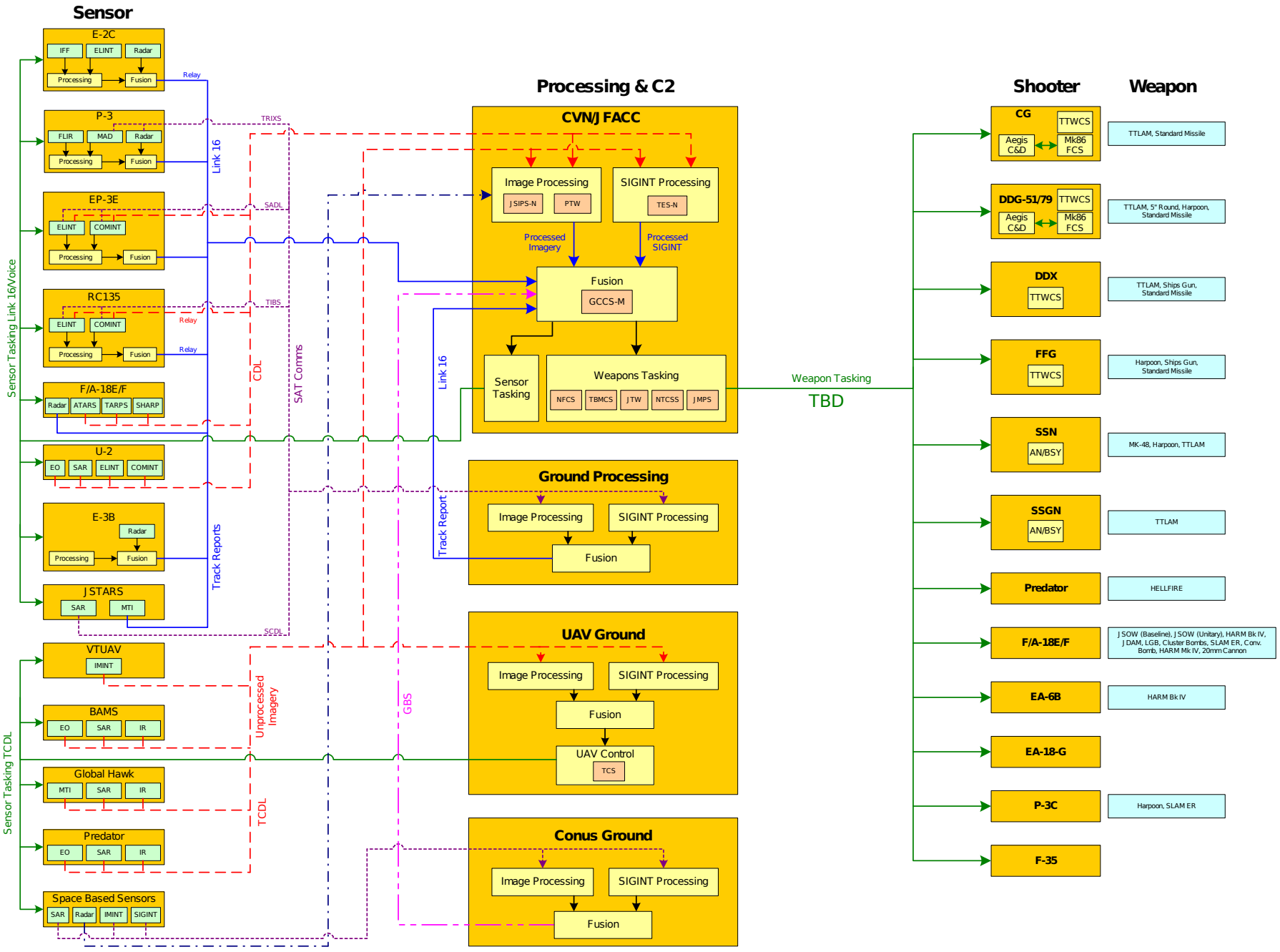
ISR & Tactical Sensors
- Threat/target detectabilities
- Sensor Type Models
- Individual Sensor Detections
- BDA Reports
- Intel Reports

NSS
Naval Simulation System

- Detailed Mission Model
- Stochastic Mission Analysis Model
  - Uses data tables to adjudicate interactions (Dice rolled)
- Scope is a critical mission with attrition and explicit communications
- C4 Modeling: Detailed
  - Explicit modeling of communications, processing, dissemination and decision in the OODA loop
- ISR Modeling: Good
  - Targets must be sensed to cause interaction
  - Sensors feed platform and superior commanders
- Behavior Modeling: Based on individual commanders perception through Decision Tables.

Single Kill Chain




Sensor
E-2C
IFF
ELINT
Radar
Processing
Fusion
P-3
FLIR
MAD
Radar
Processing
Fusion
EP-3E
ELINT
COMINT
Processing
Fusion
RC135
ELINT
COMINT
Processing
Fusion
F/A-18E/F
Radar
ATARS
TARPS
SHARP
U-2
EO
SAR
ELINT
COMINT
E-3B
Radar
Processing
Fusion
J STARS
SAR
MTI
VTUAV
IMINT
BAMS
EO
SAR
IR
Global Hawk
MTI
SAR
IR
Predator
EO
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Space Based Sensors
SAR
Radar
IMINT
SIGINT
Relay
Relay
Relay
TRIXS
SADL
TIBS
Link 16
CDL
SAT Comms
Track Reports
SCDL
Unprocessed Imagery
TCDL
GBS
Link 16
Track Report
Sensor Tasking Link 16/Voice
Sensor Tasking TCDL
Processing & C2
CVN/J FACC
Image Processing
J SIPS-N
PTW
SIGINT Processing
TES-N
Processed Imagery
Processed SIGINT
Fusion
GCCS-M
Sensor Tasking
Weapons Tasking
NFCS
TBMCS
JTW
NTCSS
JMPS
Ground Processing
Image Processing
SIGINT Processing
Fusion
UAV Ground
Image Processing
SIGINT Processing
Fusion
UAV Control
TCS
Conus Ground
Image Processing
SIGINT Processing
Fusion
Weapon Tasking
TBD
Shooter
Weapon
CG
TTWCS
Aegis C&D
Mk86 FCS
TTLAM, Standard Missile
DDG-51/79
TTWCS
Aegis C&D
Mk86 FCS
TTLAM, 5" Round, Harpoon, Standard Missile
DDX
TTWCS
TTLAM, Ships Gun, Standard Missile
FFG
TTWCS
Harpoon, Ships Gun, Standard Missile
SSN
AN/BSY
MK-48, Harpoon, TTLAM
SSGN
AN/BSY
TTLAM
Predator
HELLFIRE
F/A-18E/F
J SOW (Baseline), J SOW (Unitary), HARM Bk IV, J DAM, LGB, Cluster Bombs, SLAM ER, Conv. Bomb, HARM Mk IV, 20mm Cannon
EA-6B
HARM Bk IV
EA-18-G
P-3C
Harpoon, SLAM ER
F-35

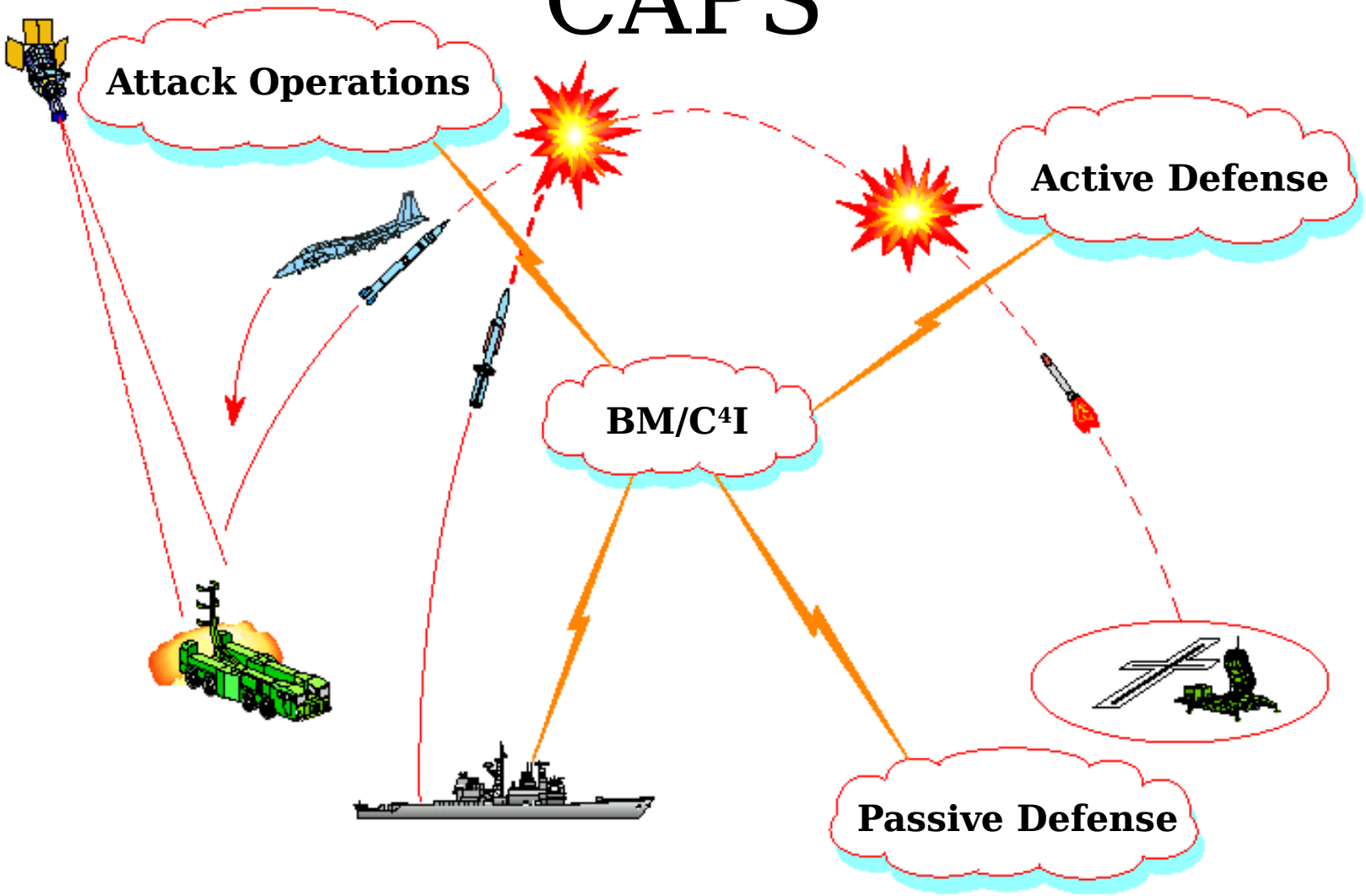
EADSIM

EXTENDED AIR DEFENSE SIMULATION
U.S. ARMY SPACE AND MISSILE DEFENSE COMMAND

EADSIM

- Detailed Air Defense Mission Model
- Stochastic Mission Analysis Model
  - Uses data tables to adjudicate interactions (Dice rolled)
- Scope is Air Defense missions including TBMD
- C4 Modeling: Air Defense Network Modeling
  - Explicit modeling of interactions of batteries
  - Capable of analyzing effects of Electronic Attack on Air Defense
- ISR Modeling: General Air Defense sensor modeling
- Behavior Modeling: Firing Rules
- EADSIM used to manual feed to ITEM for Campaign

Commander's Analysis and Planning Simulation CAPS



Commander's Analysis and Planning Simulation CAPS

- **Theater-level Air and Missile Defense Simulation**
  - –Simulates active air defense against ballistic missiles and air breathing threats by land, sea and air forces

- **BMDO Approved System Representations**

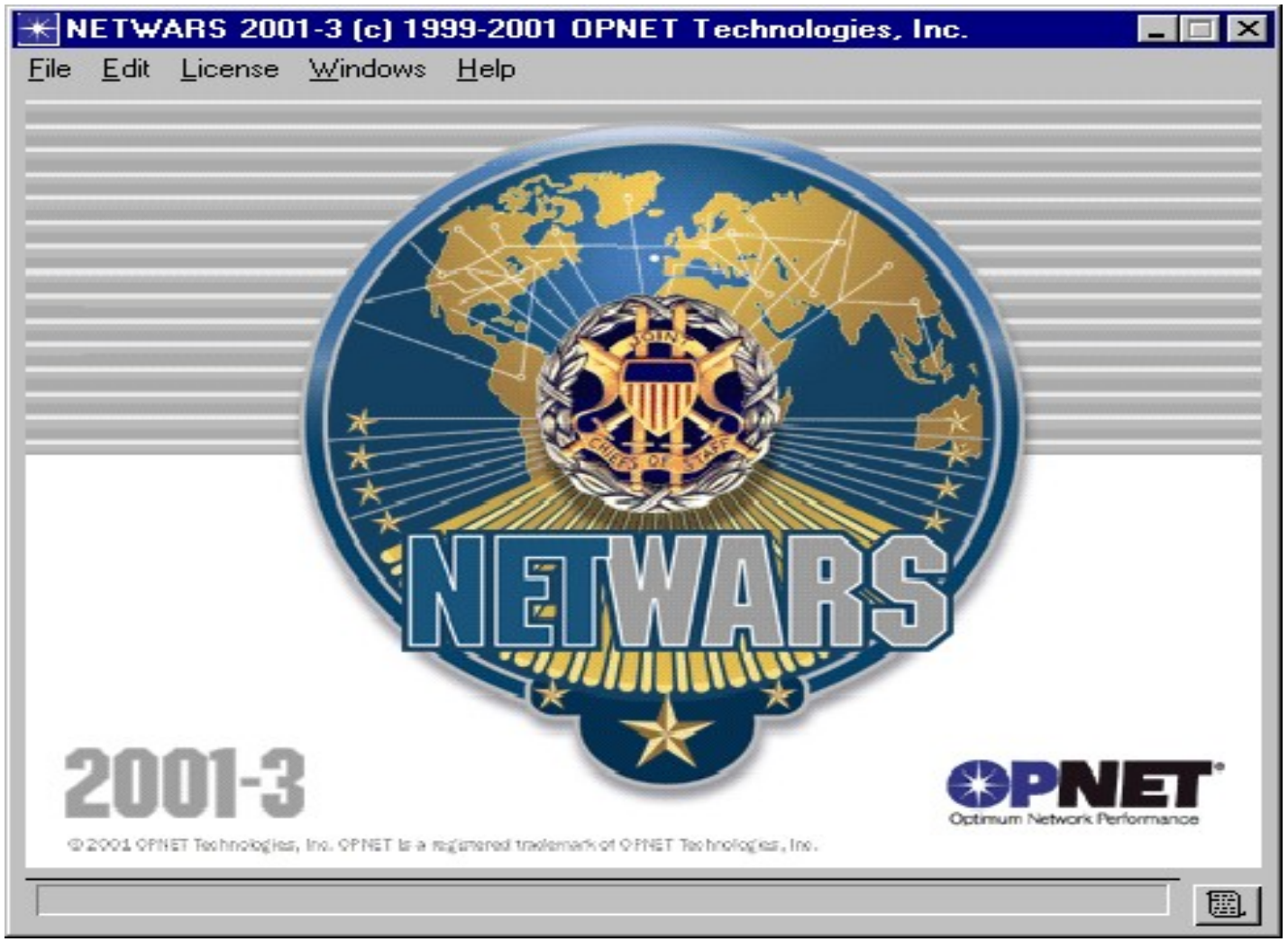
- **Includes Capability to Assess Impact of High-Level BM/C4I Architecture Variations on Theater Ballistic Missile Defense Effectiveness**
  - –C3I Sub-Model Addresses**:**
    - •Connectivity between defensive units
    - •Collection/Dissemination of cue and track data between sensor and intercept sites/platforms
    - •Alternative battle management concepts for coordinating TBMD fires
    - •Dissemination of post-launch data (in-flight target updates) to intercept sites
    - •User-friendly interface for modifications of BMC4I

SLAMEM

SLAMEM

Simulation of the **L**ocation and **A**ttack of **M**obile **E**nemy **M**issiles

- Detailed ISR Mission Model
- Stochastic Mission Analysis Model
  - Uses data tables to adjudicate interactions (Dice rolled)
- Scope is critical ISR missions with attrition and explicit communications (SCUD Hunt)
- C4 Modeling: Detailed
  - Explicit modeling of communications, processing, dissemination and decision in the ISR OODA loop
- ISR Modeling: Detailed
  - Targets must be sensed to cause interaction
  - Sensors feed platform and superior commanders
- Behavior Modeling: Based on ISR/Strike commanders perception through Decision Tables.
- SLAMEM being evaluated by N81 for use in Campaign Analysis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OPNET
Optimum Network Performance
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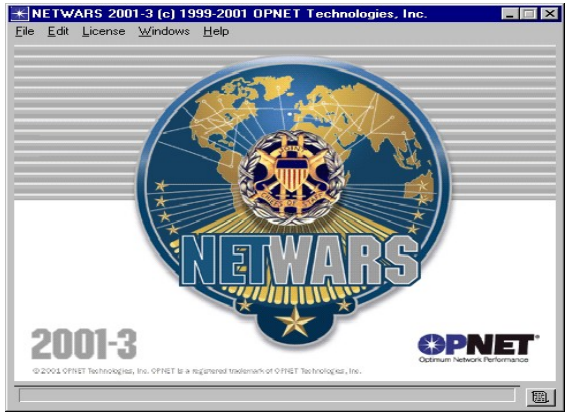
NETWARS

- Detailed C4 Network Model
- Stochastic Network Analysis Model
  - Uses data tables to adjudicate interactions (Dice rolled)
- Scope is Network Support to warfighters
- C4 Modeling: Detailed Network Modeling
  - Explicit modeling of computer communications, processing, and dissemination.
  - Capable of analyzing effects of CAN on network
- ISR Modeling: None
- Behavior Modeling: None
- NETWARS being developed to model CNA and feed NSS to measure impact on warfight.
  - Using XML to quickly develop scenario

IO Modeling



XML

NSS

Command & Control
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- Responsive Tactics and Forces Re-Direction
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True System State
- Dynamic evolution of all forces locations, status, vulnerabilities
- Interaction effects at the unit and individual platform/weapon level
- Comms at the Message/Net/Link Level among units and facilities

Tactical Picture
- Data Fusion and Tracking algorithms, with BDA
- Picture generated based on received information – can vary with command and platform

ISR & Tactical Sensors
- Threat/target detectabilities
- Sensor Type Models
- Individual Sensor Detections
- BDA Reports
- Intel Reports

IOC Version 4.0 July 2004

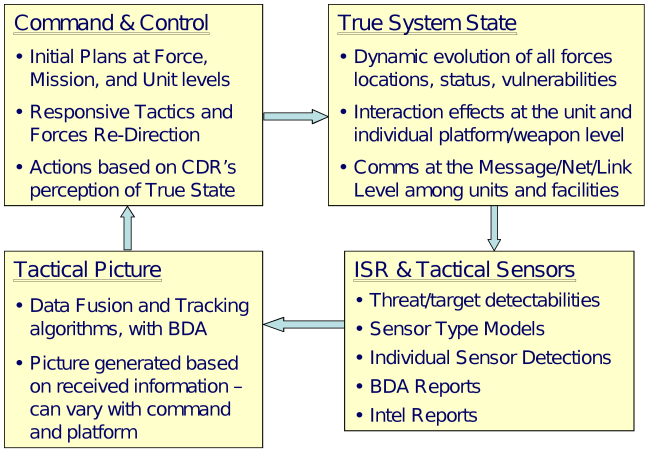
- CASTFOREM Replacement
- Closed-Form
  - No Man-in-the-loop
- High Resolution
  - Entity-level
    - **Tank**
    - **Aircraft**
    - **Ship**
    - **Dismounted Infantry**
- Stochastic
- Discrete Event
- Object Oriented
  - Java
- Joint
  - USA/USMC Effort
  - All Combat Functions
- Under Development
  - Since FY99

N81 Sponsoring effort to combine Combat XXI and NSS to build a Joint Expeditionary

Joint Expeditionary Mission Model

XMSF

NSS


Command & Control
• Initial Plans at Force, Mission, and Unit levels
• Responsive Tactics and Forces Re-Direction
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True System State
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ISR & Tactical Sensors
• Threat/target detectabilities
• Sensor Type Models
• Individual Sensor Detections
• BDA Reports
• Intel Reports

Joint Forcible Entry Options Modeling

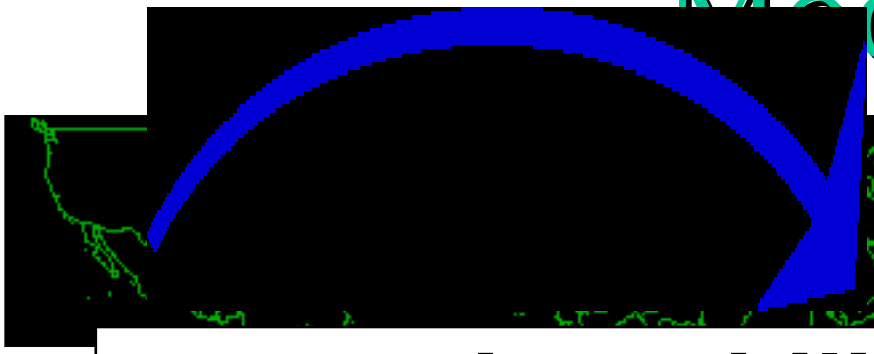
Expeditionary C4ISR Modeling

JWARS

Joint Warfare System (JWARS)

- Campaign Model
- Stochastic Mission Analysis to feed Campaign Picture
  - Uses data tables to adjudicate interactions (Dice rolled)
- Scope is Mission modeling to build Campaign outcome
- C4 Modeling: General
  - Explicit modeling of communications, processing, dissemination and at the Task Force Commander level
- ISR Modeling: Good
  - Targets must be sensed to cause interaction
  - Sensors feed platform and superior commanders
- Behavior Modeling: Based on individual commanders perception through Decision Tables modified by Phase of Operations and State of Unit.
- JWARS is still in experimental Phase
- N81 evaluating JWARS for suitability for OPNAV Campaign Analysis

Joint Integrated Combat Model



Air Combat

Strategic Mobility

Land Comba

Ballistic / Cruise Missiles & TBMD

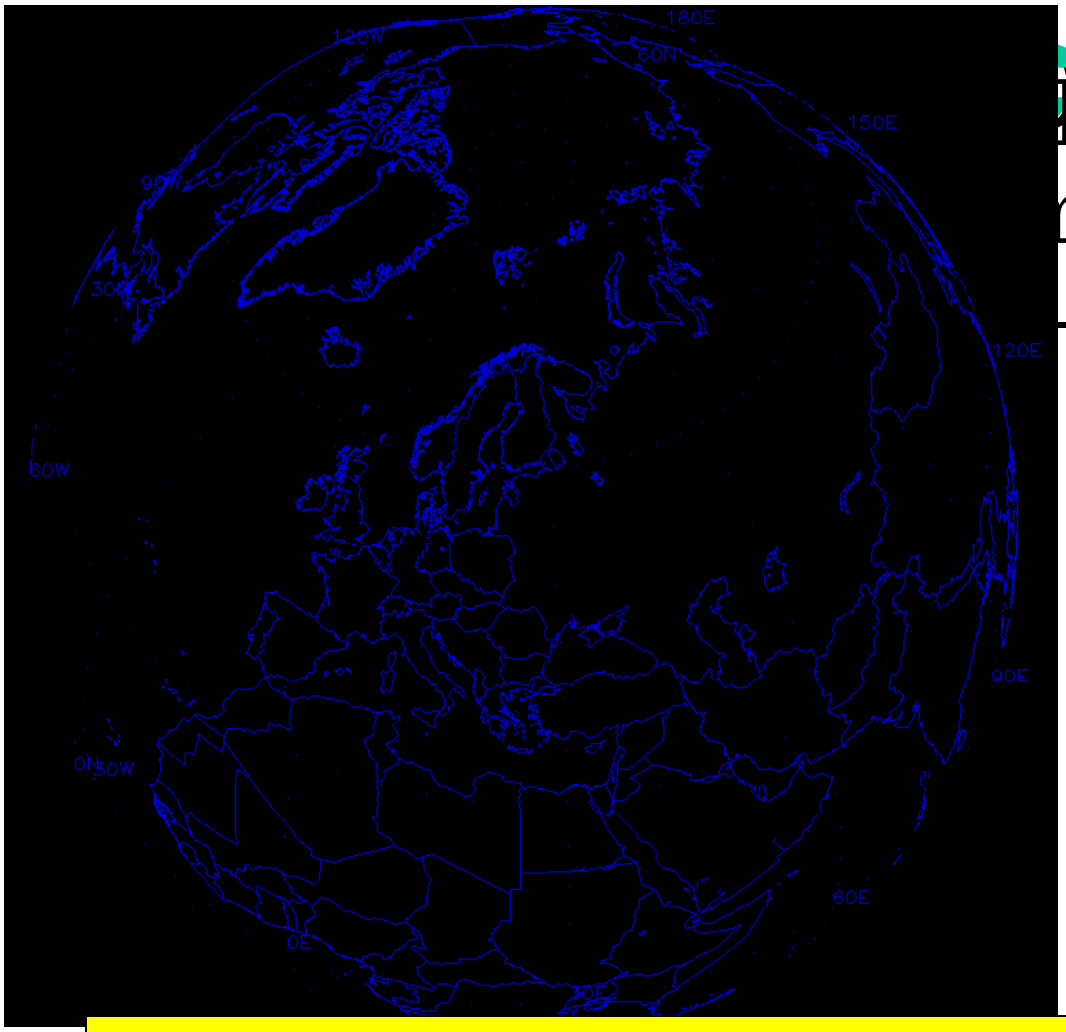
Amphibious / Airmobile / Airborne Insertions

laval Combat

Joint Integrated Combat Model
JICM

- Campaign Survey Model
- Deterministic Survey Campaign Model
  - Uses expected value
- Scope is Campaign Modeling
- C4 Modeling: None
- ISR Modeling: None
- Behavior Modeling: Scripted
- Designed to quickly survey the scenario space to identify areas of interest.
  - Must be followed up by more detailed model such as ITEM, GCAM & NSS.
- N81 evaluating JICM for suitability for OPNAV Campaign Analysis

JICM World Perspective



- JICM is a world model
  - Functional models in the JICM environment are integrated by
    - operating in and
    - affecting the state of this world

N81 evaluating JWARS for suitability for OPNAV Campaign Analysis

Navy Common Data Base

- Data Base to support OPNAV M&S
  - Expand to serve all DoN Analytical modeling
  - Identification of “Authoritative Data”
- Non-Model Specific Data Repository
- Employ XML for Model Specific Transformations
- Meta Data Included
- Advisory Committee includes SYSCOMs, RAND, JHU/APL and others

Operational Availability Data

- OPNAV Campaign Analysis includes A_o Data
- Current Systems Data provided by SYSCOMs
- Future Systems Data provided by N70 (ORD Values)
- Study to analyze past ORD versus actual performance data to be conducted by JHU/APL

M&S Methodology Review

Methodology Improvement Working Integrated Process Team (MI-WIPT)

- Required by senior leadership concerns about M&S
- Purpose is to review M&S practices and come to consensus about “Best Practices” for OPNAV staff
- Chaired by N81. OPNAV staff sit as permanent members. Advisory members include SYSCOMs, PEOs, etc.

M&S Methodology Review

Methodology Improvement Working Integrated Process Team (MI-WIPT)

- Process:
  - Review Current Practices (Transparency)
  - Identify Risks
  - Find Consensus for Improvement
  - Documentation
- Requirements:
  - Integration
  - Aggregation
    - More detail is not always the answer

M&S Methodology Review

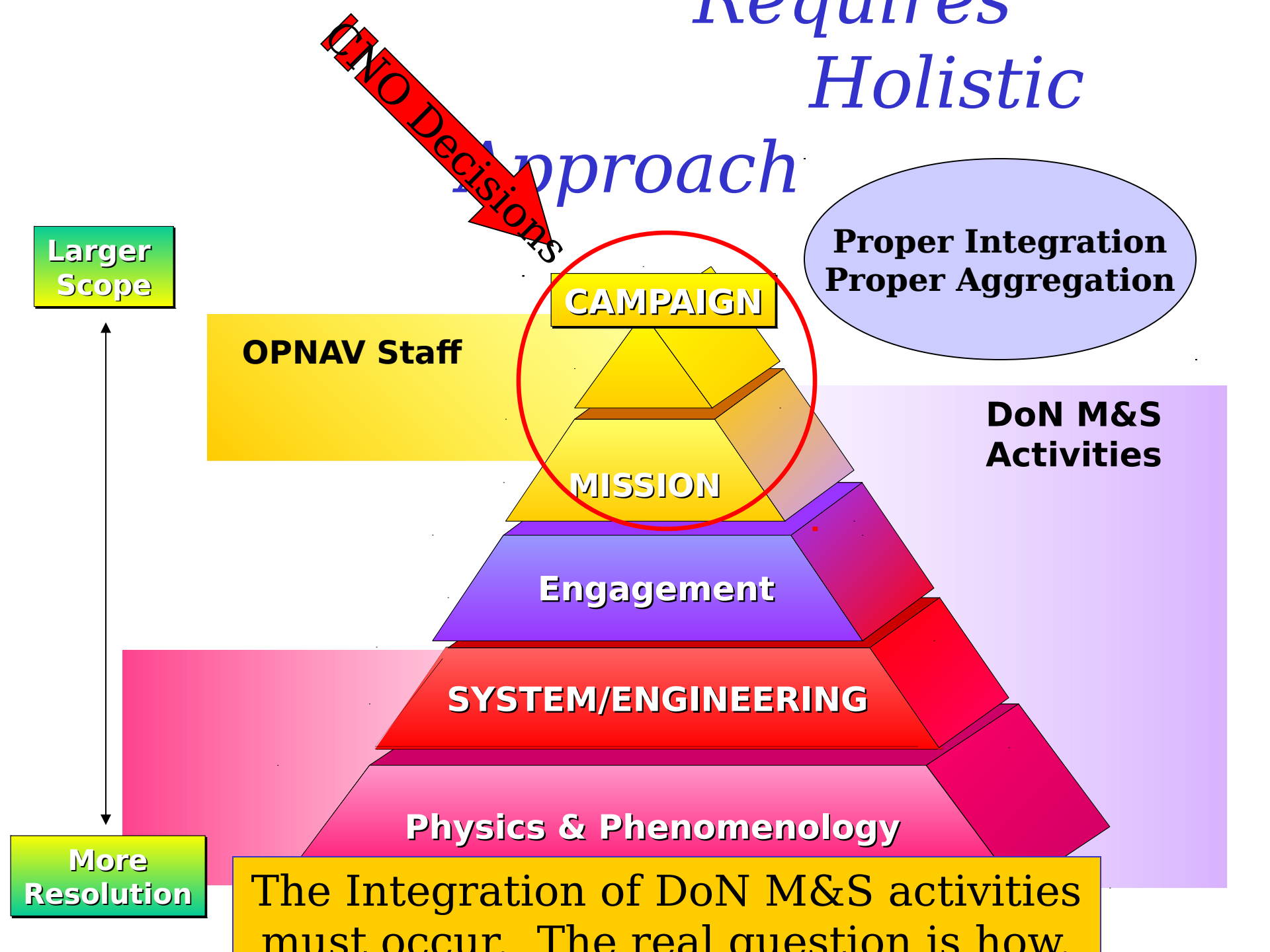
Methodology Improvement Working Integrated Process Team (MI-WIPT)

- Current Projects:
  - ASW
  - TAMD
  - Ship Damage
  - MIW
  - CID
  - BDA
- Over 24 warfare areas identified by members

VV&A

- VV&A of Key Models
  - ITEM
  - GCAM
  - COSMOS
  - NSS
- VV&A Data
  - NCDB
  - Ao Review
- VV&A Methods
  - MI-WIPT

Requires Holistic Approach



The Integration of DoN M&S activities must occur. The real question is how.

Questions?

Backup Slides

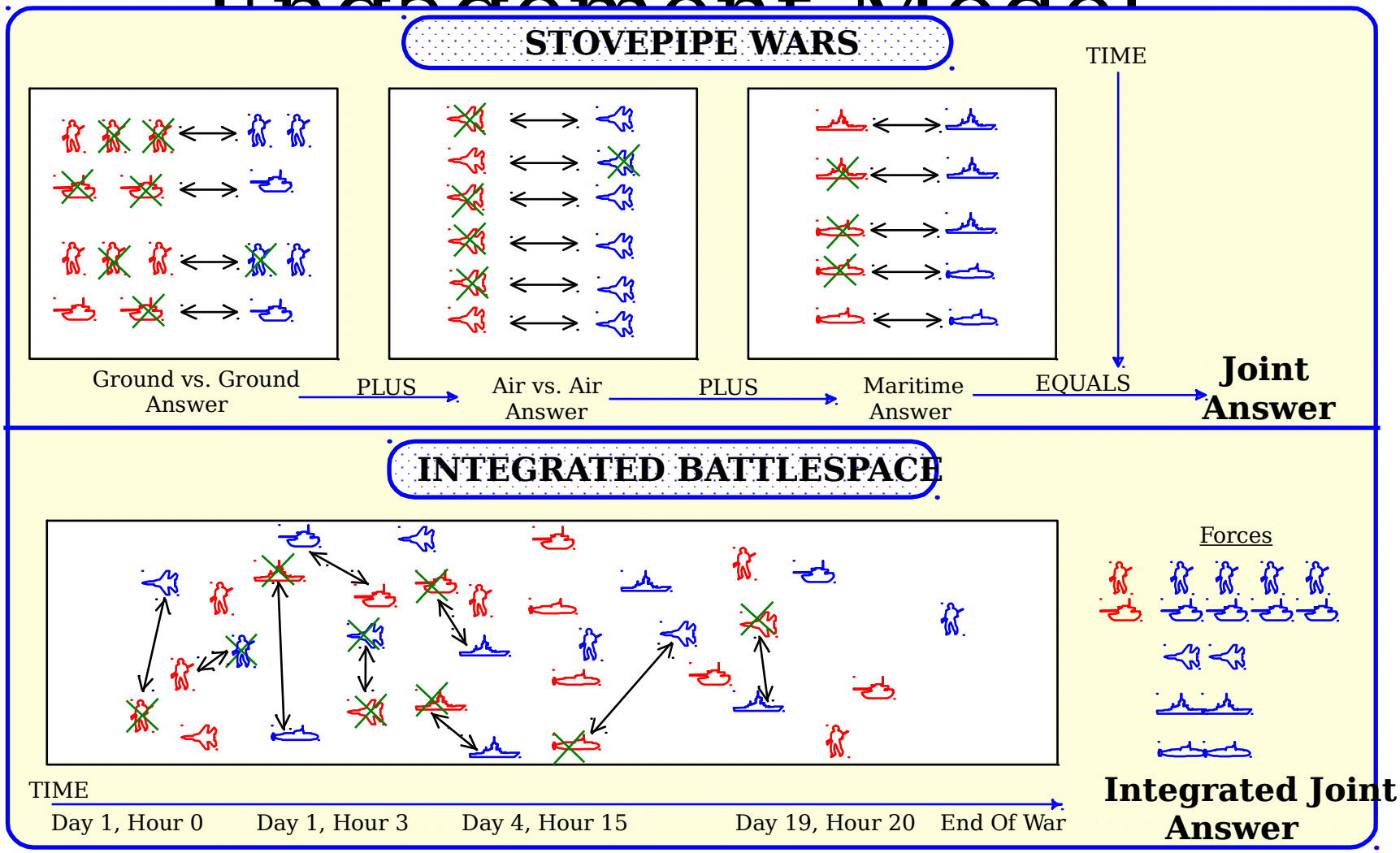
Integrated Theater Engagement Model (ITEM)

- Provides fully integrated air, land, and naval warfare engagement modules for the analysis of joint-force operations in theater level campaigns.
- Developed to perform theater-level analyses of joint operation in various phases of a conflict.
- Original intent of ITEM
  - Course of actions assessments for campaign planning
  - Theater or global mix assessments
  - Joint Force effectiveness assessments
  - Theater-level or global resource planning
  - Combat doctrine development and assessment
  - Campaign strategy evaluations
  - Policy studies where theater or global perspective is required

ITEM Engagement Capabilities

- Sortie Package Effectiveness
  - Strike Package Composition
- Weapon Effectiveness
  - All-weather (GPS) weapons vs. weather restricted (GBU) weapons
  - SOW vs. Direct Attack
- Aircraft Load vs Target
- Weapon mix vs target mix
  - Flow of ordnance into theater
  - Composition of ordnance on carrier
- TLAM or LASM vs. strike sorties
- Air to Air Engagements
- NSFS

Integrated Theater Engagement Model

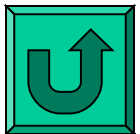


GCAM Core Tool Suite (*CTS*)

- Developed By SPA For Navy Assessment Division (N81)
- PC Based Object Oriented Modeling Environment
- Variable Levels Of Resolution: Joint Campaign To Engagement Level
- Users Include OPNAV, MCCDC, Navy Warfare Centers, Joint Staff, and CINCs
- Applicable For Spectrum Of Military Operations
  - Major Theater War (MTW)
  - Small Scale Contingency (SSC)
  - Military Operations Other Than War (MOOTW)
  - Forward Presence and Contingency Response
- Navy Contribution To Joint Analytic Modeling Improvement Program (JAMIP) Suite Of Models

Key *GCAM-CTS* Capabilities

- Environment For Rapid Development and Execution Of Stochastic Simulation Models
- DMSO High-Level Architecture (HLA) Compliant
- Designed For Use By Military Operations Research Analysts
- Facilitates Customized Approach To M&S-based Analyses With Application-Specific…
  - Data Input Requirements
  - Overall and Individual Warfare-area Levels Of Resolution
  - Output MOE/MOPS
  - Modeling Approach



COSMOS

Overview

- Objective
  - Assess & compare performance of C4ISR architecture alternatives from tactical to global scale
- Scope
  - National, theater, and organic assets
  - Sensors, C4I elements and weapon systems
  - Single platform to large "system of systems"
  - Space, air, naval, and ground-based platforms
- Explicitly considers
  - Platform operations
  - Sensor characteristics and performance
  - Target signatures and behaviors
  - Processing, exploitation, and dissemination of information
  - Communications and network information flow

COSMOS

Model Applicability & Assumptions

COSMOS allows considerable flexibility in defining study scope…

Attack Operations

How can a given C4ISR architecture be modified so as to improve its effectiveness in finding and neutralizing enemy TELs before launch?

- Targets: individual vehicles
- Individual sensors & ISR platforms
- Entire C3 network, with consideration given to bandwidth and throughput

Major Theater of War

What mix of sensors, platforms, communications systems, etc. will be most effective in supporting the commander's theater battlespace awareness?

- Targets: company-level resolution
- Individual sensors & ISR platforms
- Aggregate C3 network

COSMOS

COSMOS Data Sources

Defense Airborne ISR Plan (DAISRP)

- OASD C3I

Program Offices for specific Blue Platforms

Office of Naval Intelligence (ONI/N2)

Defense Intelligence Agency (DIA)

National Ground Intelligence Center (NGIC)

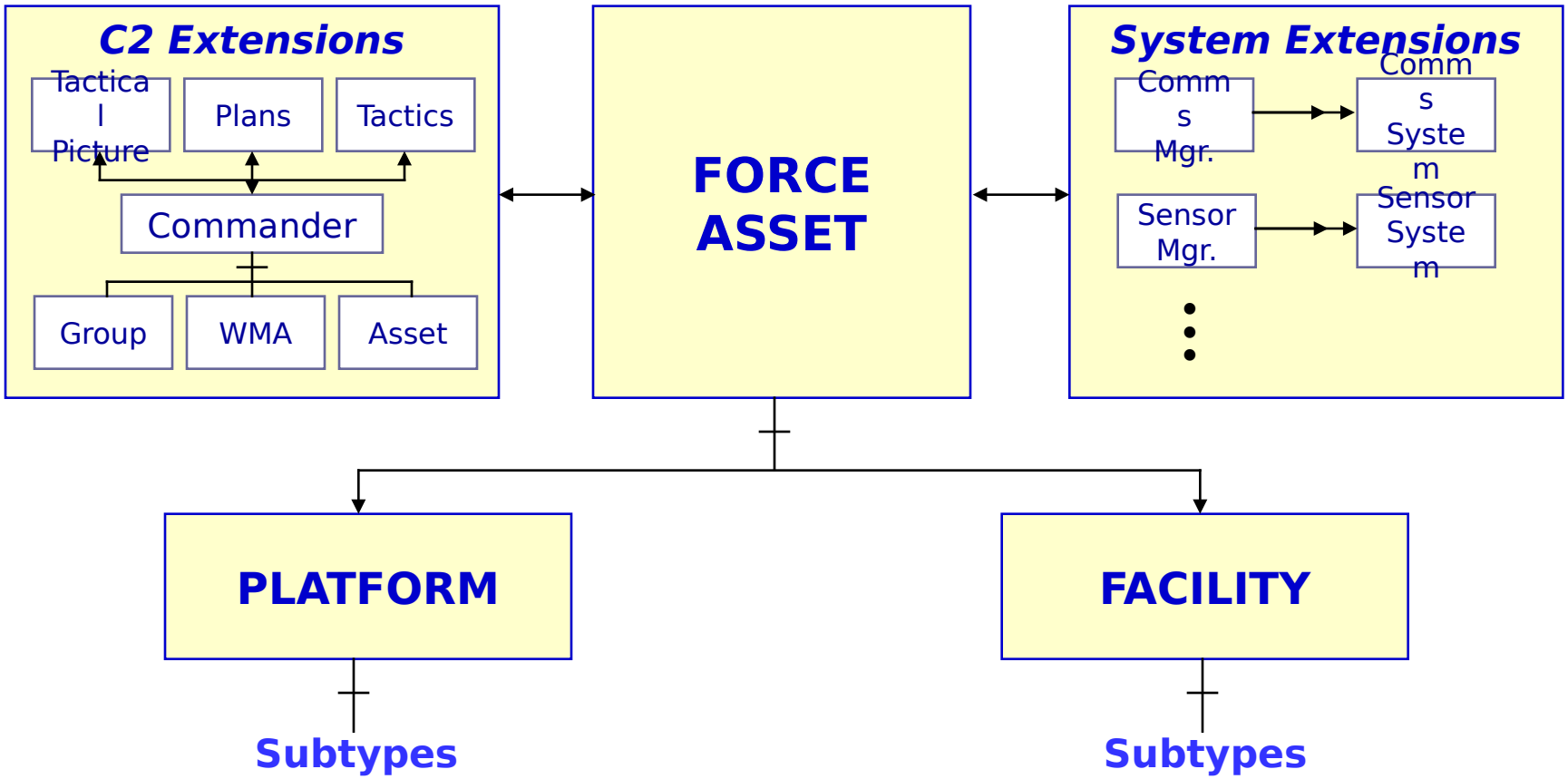
Investments in COSMOS

- Improved Maritime ISR modeling
- Improved modeling of Maritime Targeting
- Improved modeling of persistent ISR requirements
- Requires advisement on best methods to use
- Continue development of NSS connections

Key NSS Innovations

- Provides the means to explicitly represent C4ISR and to measure relevant metrics in mission-to-campaign level scenarios.
- Explicit C4ISR includes representation of:
  - Platforms, systems, and commanders,
  - Command organization (group, mission, platform),
  - Commander's plans and doctrine,
  - Information collection,
  - Information dissemination,
  - Fusion + dynamic planning/re-planning, and
  - Warfighting interactions.
- Supports assessment of Joint/Naval system/concept improvements including determination of cause-and-effect relationships between architectural parameters and warfighting outcome.

Object Model



NSS Representations

Platforms and Facilities

Types	**Platforms:** satellites, aircraft, missiles (cruise and ballistic), ships, submarines, land vehicles. **Facilities:** airports, ports, buildings, sites.
Motion	Great circle or rhumbline multi-leg tracks, random patrols, ballistic missiles, satellite orbits.
Components	Targetable components with associated functionalities. Components can be damaged and subsequently repaired based on MTTR inputs.
Logistics	Replensihable items (RI's), e.g. fuel, weapons, which may be required to conduct certain operations. Associated consumption methods and requisition thresholds.
Systems	Platforms and facilities may have associated user-defined comms, sensor, weapon, countermeasure, and logistics system suites.
Vulnerabilities	User-defined detection susceptibilities vs. radar, ELINT, COMINT, IR, PHOTINT, and acoustic sensors. Susceptibility periods and levels are user-defined.
Commanders	Asset commander (controlling local systems and holding local plans and tactics) plus one or more embarked Group and/or WMA commanders.

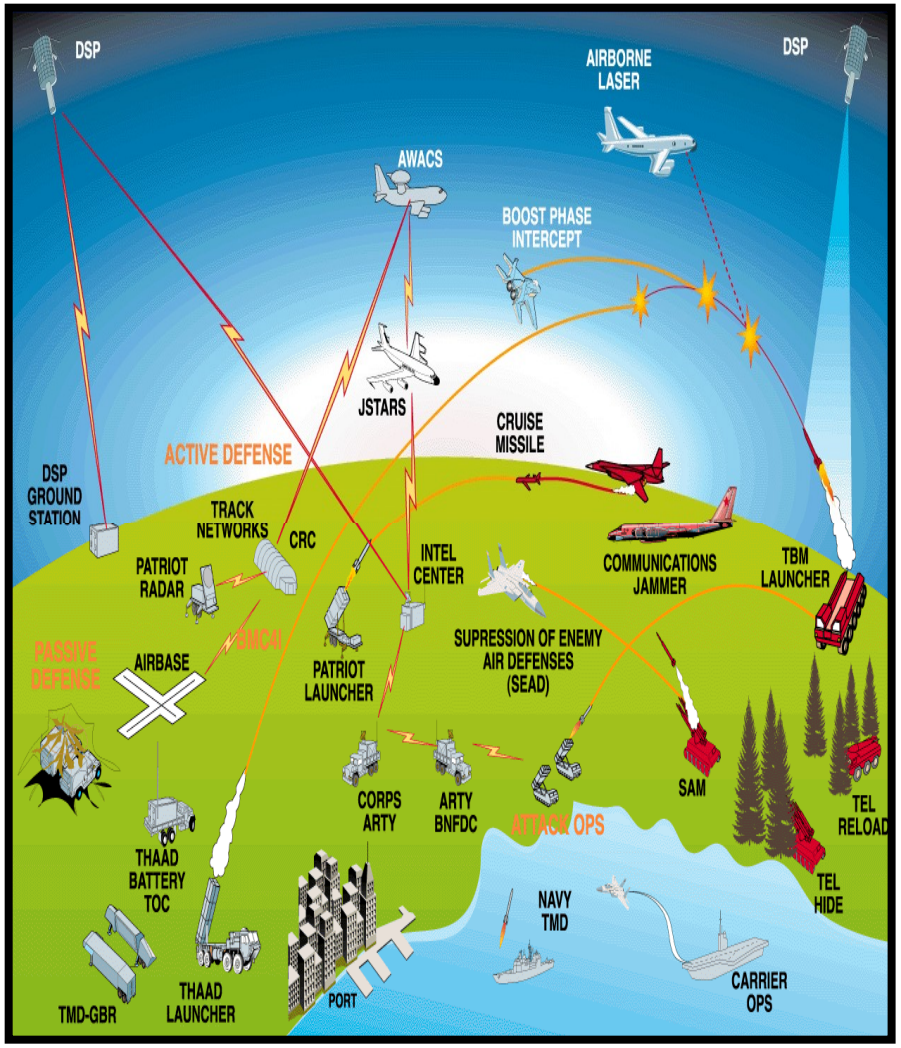
NSS Representations

	Comms	Sensors/CM's	Fusion	Weapons/CM's	LOG
Types	Satellite, point-to-point, routed, tactical data links	Radar, ELINT, COMINT, IR, PHOTINT, Acoustic. Radar/Comms Jamming	Spatial based contact-to-track correlation and fusion.	Cruise/ballistic missiles, guided weapons, bombs, torpedos, guns, mines. Mine sweeping.	Inport and underway replenishment. Regional and group replenishment scheduling
Levels of Resolution	- Assured with delays, - Unassured/routed with constraints, - Protocol	- Simple parametric, - Complex parametric, - Specific systems.	- DR with perfect correlation, - DR with imperfect correlation, - KF with imperfect	- Range, Pk, flyout delay, - Scheduled weapon system, - Explicit flyouts.	- Infinite supply, - Finite supply with implicit re-supply, - Finite supply with explicit re-supply,
Specifics	Specific message types including contacts, track updates, command, status, acknowledge. Multi-net routes. Backup and redundant routes. Constraints including LOS, range, delays, error rates, etc.	Report content including position, velocity, class, ID, count, BDA. Accuracies and uncertainties. Complex 3D coverage volume constraints. Target and environment dependencies.	Track initiation. Contact to track correlation. Track state estimation and projection.	Scheduling of weapon system components including illuminator, launcher, radars. Complex 3D coverage volume constraints. JMEM-based ground damage effects. David Taylor model based ship damage.	Default schedule including ports, shuttle ships, and stations ships. Requisition order based re-supplies. Logistics operations and facilities (pumps, cranes) explicitly represented.

Additional New NSS C4ISR Capabilities

- Battle Damage Assessment
  - False positive
  - False negative
- Combat Identification
  - False positive
  - False negative
- Basic MIW

EADSIM Areas of Focus



- Air Defense
  - SAMS, Defensive Counter Air, Command & Control, etc.
- Offensive Air Operations
  - Offensive Counter Air, SEAD, etc.
- Support Operations
  - Surveillance, Early Warning, Refueling, Airbase Operations, etc.
- Attack Operations
  - Surface-to-Surface, Attack Helicopter, Reconnaissance, etc.
- Electronic Warfare (ECM & ECCM)
  - Jamming, Decoys, Counter Measures, etc.
- Space Warfare
  - Satellites, Lasers, Communications, etc.

Strengths and Weaknesses

- Strengths
  - Well-respected model in the analytic community
  - Used extensively in the TBMD and CMD communities
  - IADS representations
    - C3I modeled in depth
    - SAM engagements
  - Multi-level fidelity of sensors
  - Inclusion of DTED
  - Each platform explicitly modeled
  - Relatively fast runtimes for an analytic model
- Weaknesses
  - No ability to modify source code
  - Tedious to edit/modify text files
  - Weather effects are not included
  - Unable to play multi-day campaign or land war
  - Relatively fast runtimes for an analytic model

Running the Model

- Simulation Setup
  - Primarily done through graphical interface
  - Can also import data from some other sources, ie MSFD
  - ➢ *User friendly not fast*
- Running a Simulation
  - Multiple runs preferred for statistical significance
  - 5-30 minutes per run
  - ➢ *Fast for an analytic model*
- Analyzing Results
  - Graphical playback is useful but not analytic
  - Non graphical post processing can produce very detailed information in large quantities – planning required
  - ➢ *Labor Intensive to change analysis processes on the fly*

WHY CAPS?

- Single Integrated Tool That Gives the Analyst the Capability to;
  - Study various theater air and missile defense designs
  - Vary technical parameters
  - Understand operational constraints of defensive systems
  - Develop/Assess functional representations of JDN, CEC, and JCTN
- Several Levels of Diagnostics Available
- Fidelity Comparable To Other Community Standard Models (e.g, EADSIM)
  - CAPS uses readily available EADSIM data
    - Interceptor flyout tables
    - Pk tables
    - Radar cross section files
    - Flight trajectories
  - Data reviewed by Program Office (BMDO) annually

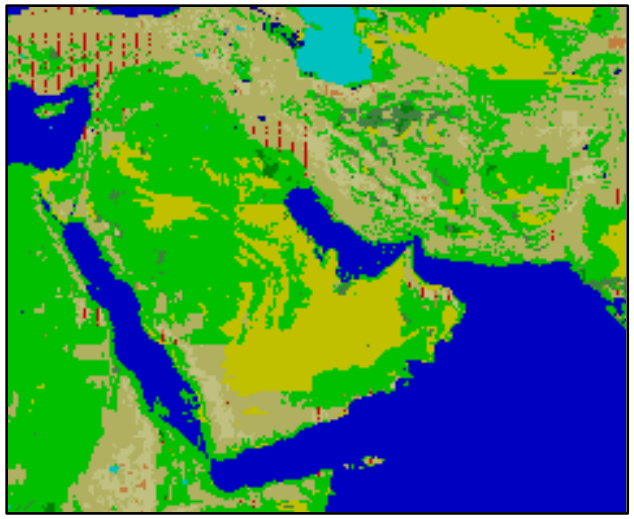
CAPS MODEL OVERVIEW (1 of 3)

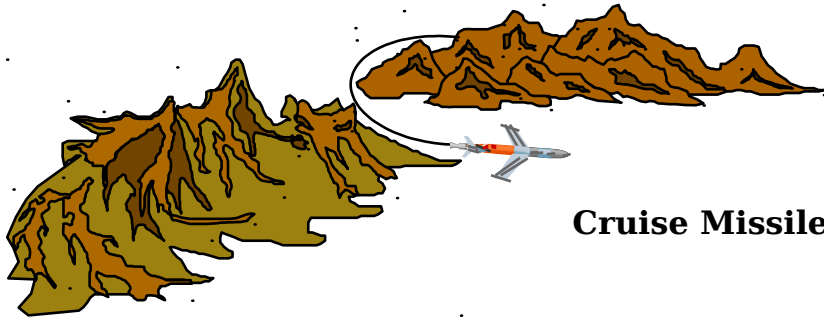
- World-Wide Topography
  - Both low resolution (ETOPO-5) and high resolution terrain data from DTED
  - Vegetation data provided by Fleet Numerical Oceanographic Center (FNOC)

- TBM Trajectories
  - Rotating or non-rotating earth (Joint National Test Facility data) **or**
  - EADSIM ballistic missile trajectory files **or**
  - User specified TBM/ABT trajectory data

- Cruise Missiles Modeled With Waypoints With or Without Aerodynamic Constraints
  - Existing threat data **or**
  - User specified CCM routes varying velocity, altitude and flight profile

FNOC for South West Asia

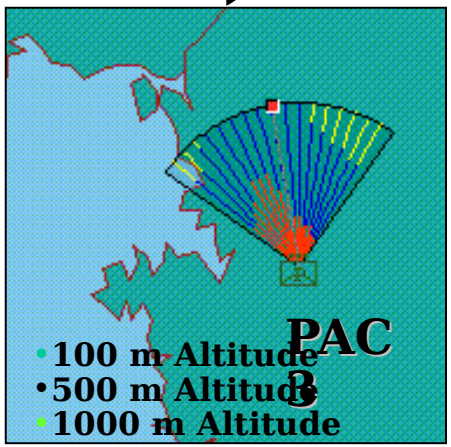




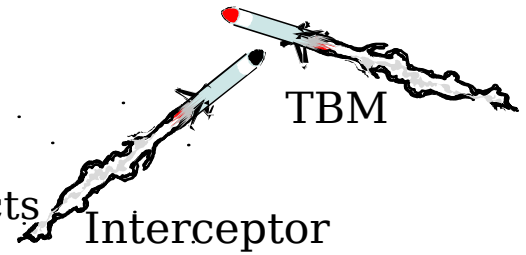
CAPS MODEL OVERVIEW (2 of 3)

- Radar Model
  - Simulates the detection of threat objects by radar systems based on land, at sea, or onboard aircraft
- Simple Infrared Detection Model Used for SBIRS
- Interceptor Engagement Model
  - Simulates each attempt to intercept a threat object by a specified interceptor
- Battle Management Model
  - Defines the strategy that governs each engagement of a threat object by an interceptor site
- Command, Control, and Communications Model
  - Defines communications links (nets) among defensive units
  - Allows sensors to cue one another to active threat objects
  - Provides commit data to interceptor sites
  - Provides post-launch support to interceptors in flight

Example Intervisibility

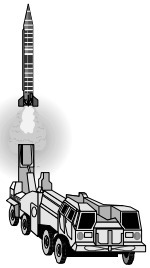
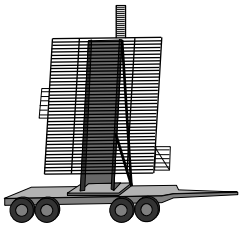
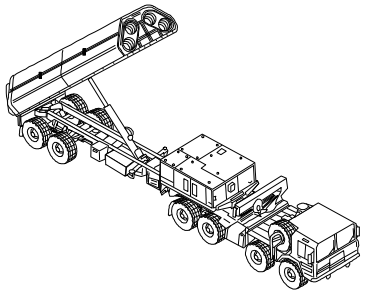


Endgame



CAPS MODEL OVERVIEW (3 of 3)

- Example BMD Systems Modeled
  - PATRIOT (PAC-2, GEM, PAC-3)
  - Theater High Altitude Area Defense (THAAD)
  - Navy Area and Theater Wide Defense (NAD, NTW)
    - AN/SPY-1 B/D, SM2BlkIVa, SM2BlkIII, SM3/LEAP
  - Air Borne Laser (ABL)
  - ARROW
  - Avenger
  - I-HAWK
  - AWACS, E-2C
  - Advanced Sensors (JLENS)
  - Early Warning Radars
  - Fighters (F-15, F/A-18)
  - DSP/JTAGS/ALERT, SBIRS
  - Space-Based Laser (SBL)

ISR Systems Analysis

- SLAMEM models the technical breadth and depth of complex real-world sensor systems analyses.
- Relevant expertise includes:
  - Sensor design and systems analyses
    - Radar, ELINT/SIGINT, Optical
  - Aerospace mission analyses
    - Air-breathing (Predator-to-U-2s)
    - Spacecraft and orbitology
  - Sensor-to-shooter systems analyses
    - Multi-INT fusion, tracking, dynamic sensor tasking

Simulation of the
Location and
Attack of
Mobile
Enemy
Missiles

- SLAMEM™ developed from a twenty year legacy of providing feasibility studies and operations/mission/utility analyses for high-level planners and decision makers within the Department of Defense, the armed services, and the aerospace industry.
- SLAMEM is a powerful simulation tool used to evaluate the utility of advanced sensor systems in a realistic environment.
  - Flexible operational architectures: platforms, payloads, data linkages
  - Component fidelity is driven by user needs and requirements
  - Captures important dynamics of time-critical targeting

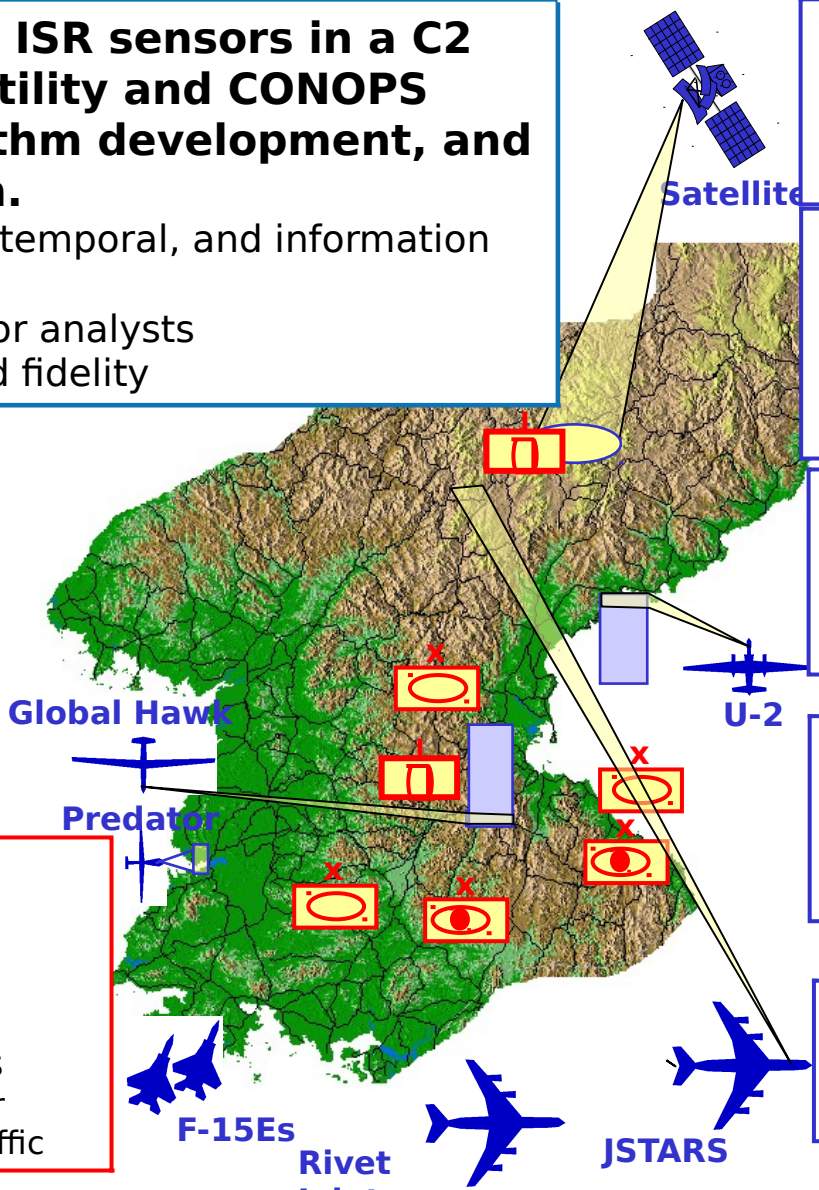
SLAMEM Overview Components

SLAMEM models ISR sensors in a C2 framework for utility and CONOPS analyses, algorithm development, and experimentation.

- Simulates spatial, temporal, and information domains
- Built by analysts for analysts
- Balance speed and fidelity

Environment
- Terrain elevation
- Road networks
- Foliage cover
- Atmospheric
- Urban buildings

Ground Vehicle Simulator (GVS)
- High-fidelity motion models
- RF-emission models
- Special Target Behavior
- Background Clutter Traffic



Tasking
- Dynamic sensor management
- Multi-platform tasking

ISR Assets and Sensors
- Ground, air, space platforms
- Sensor performance modeling

Exploitation
- Human Analyst Exploitation
- Automated exploitation

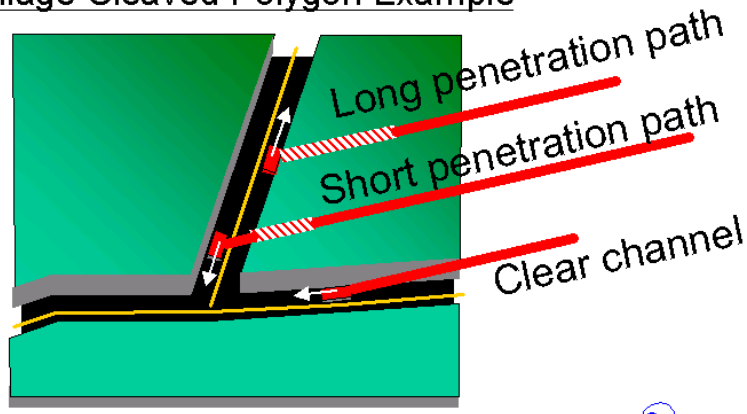
Operation Center
- Dynamic CONOPS
- Multi-INT fusion and tracking

Attack Cell
- Manned aircraft
- Surface-to-surface missiles

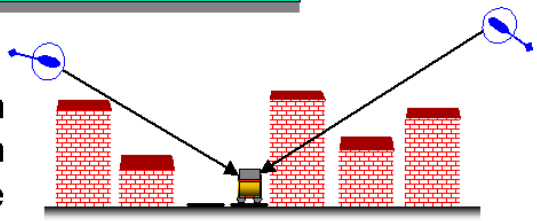
Detailed Environment Model

- Terrain – DTED
- Buildings
  - Statistical cities “built”
  - Urban canyons
  - Import CTDB databases
- Foliage – VMAP or custom
  - Forest polygon
  - Road cleaving
- Atmospheric
  - Clouds, smoke, fog
- Routes – VMAP, DFAD, DCW
  - Roads, rail, shipping, other
  - Customizable
  - Multiple road types

Foliage Cleaved Polygon Example



Urban Canyon Example



Line of Sight Check

1. Ray trace from sensor position to target
2. Hard blockage – terrain, building, or vehicles
3. Soft blockage – foliage, clouds, fog, smoke

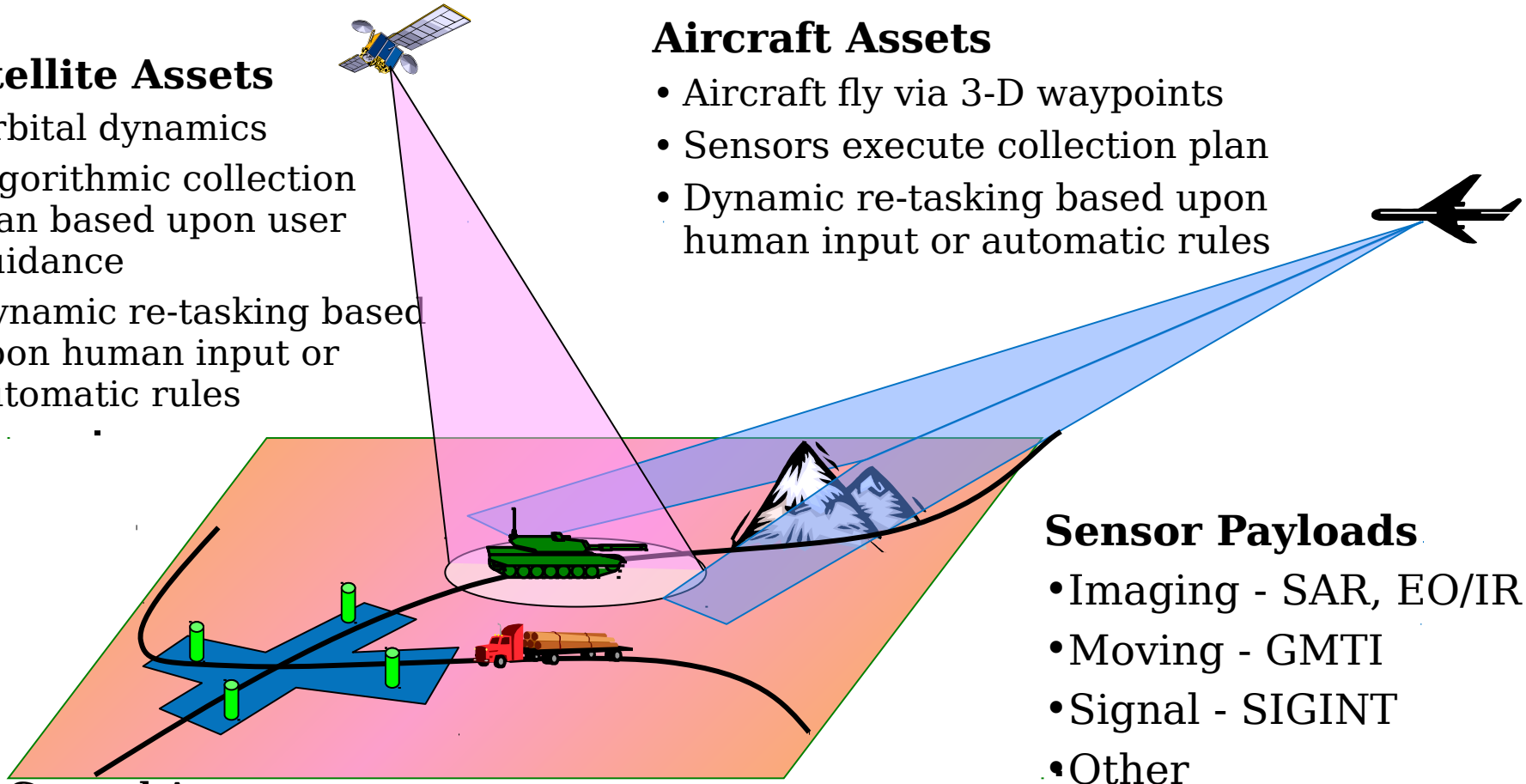
Modeling of Space, Air, and Ground Platforms

Satellite Assets

- Orbital dynamics
- Algorithmic collection plan based upon user guidance
- Dynamic re-tasking based upon human input or automatic rules

Aircraft Assets

- Aircraft fly via 3-D waypoints
- Sensors execute collection plan
- Dynamic re-tasking based upon human input or automatic rules



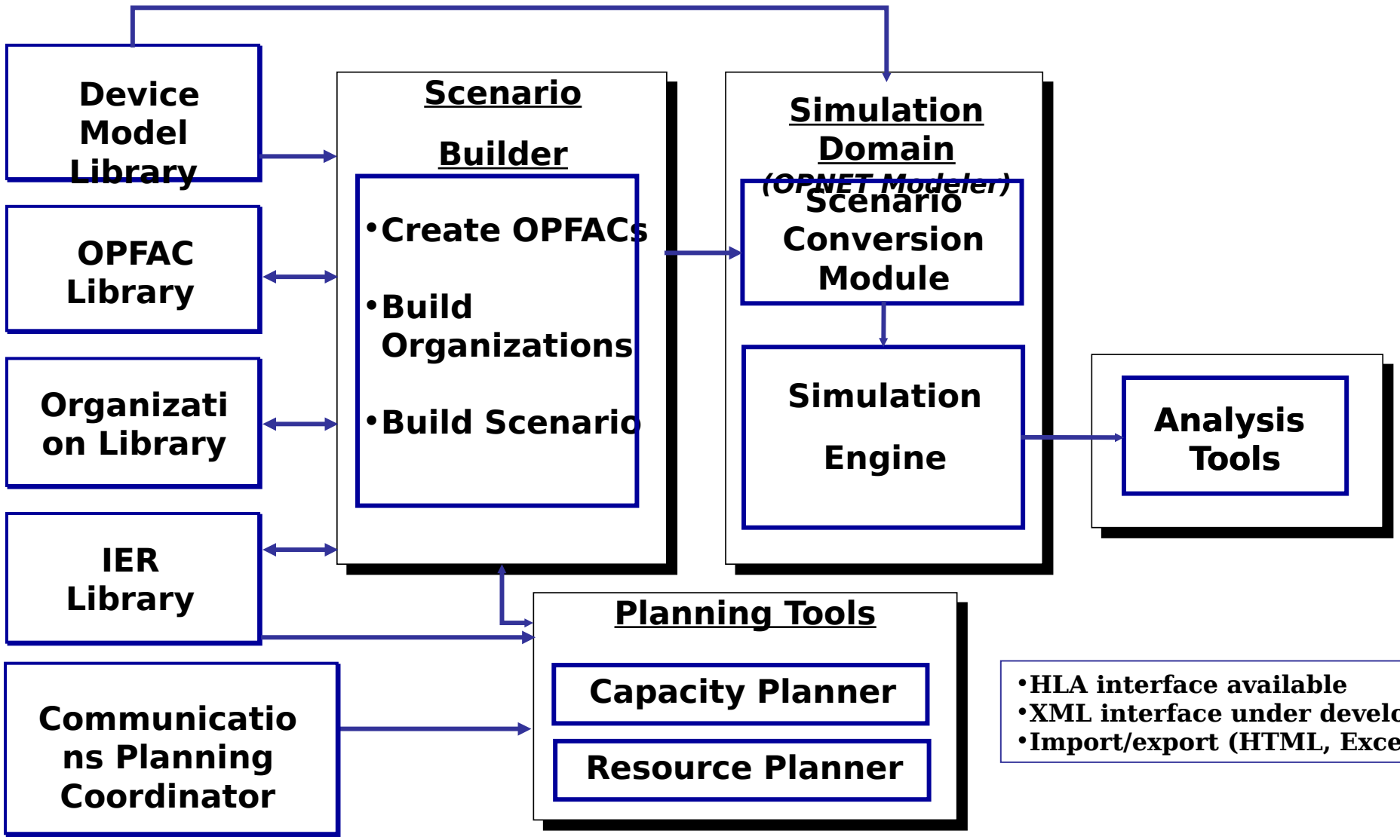
Ground Assets

- Unattended Ground Sensors (UGS)
- Special Operations Forces (SOF)
- Aggregate Sensor Fields

Sensor Payloads

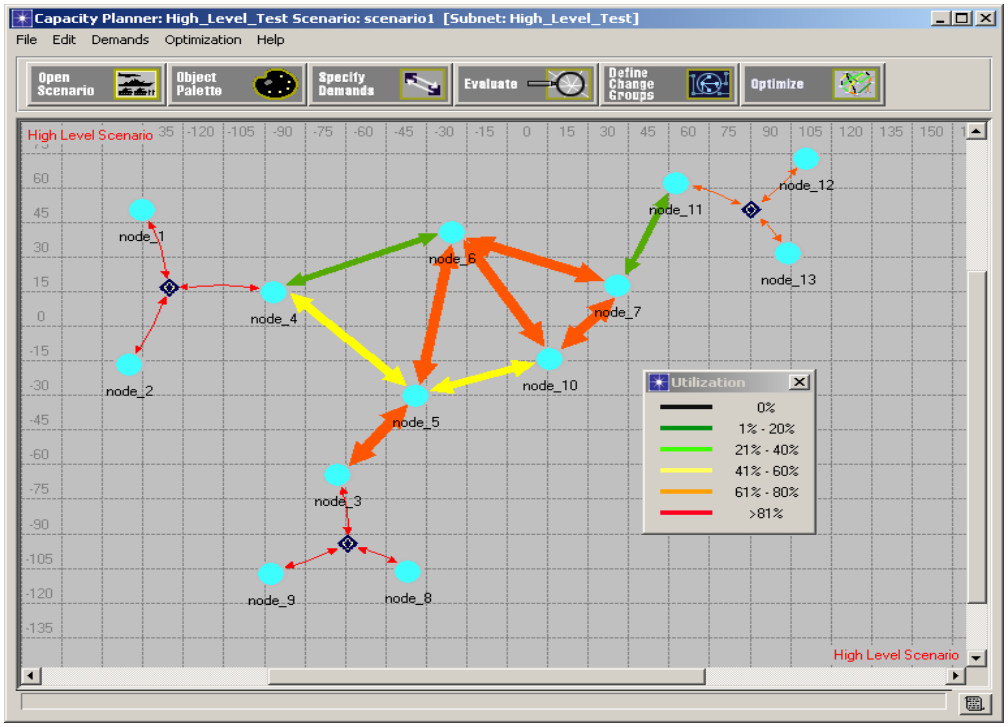
- Imaging - SAR, EO/IR
- Moving - GMTI
- Signal - SIGINT
- Other
  - –Seismic
  - –Acoustic
  - –Magnetic
  - –HUMINT visual

NETWARS Simulation Architecture



Contingency Planning Capabilities

- Capacity Planning
  - *What network configuration is needed to satisfy stated requirements?*
- Resource Planning
  - *How can current, fixed network(s) be used most effectively?*
- Comm Planning Coordinator
  - *Tool to facilitate current collaborative planning processes*



FY02 NETWARS Validation Study

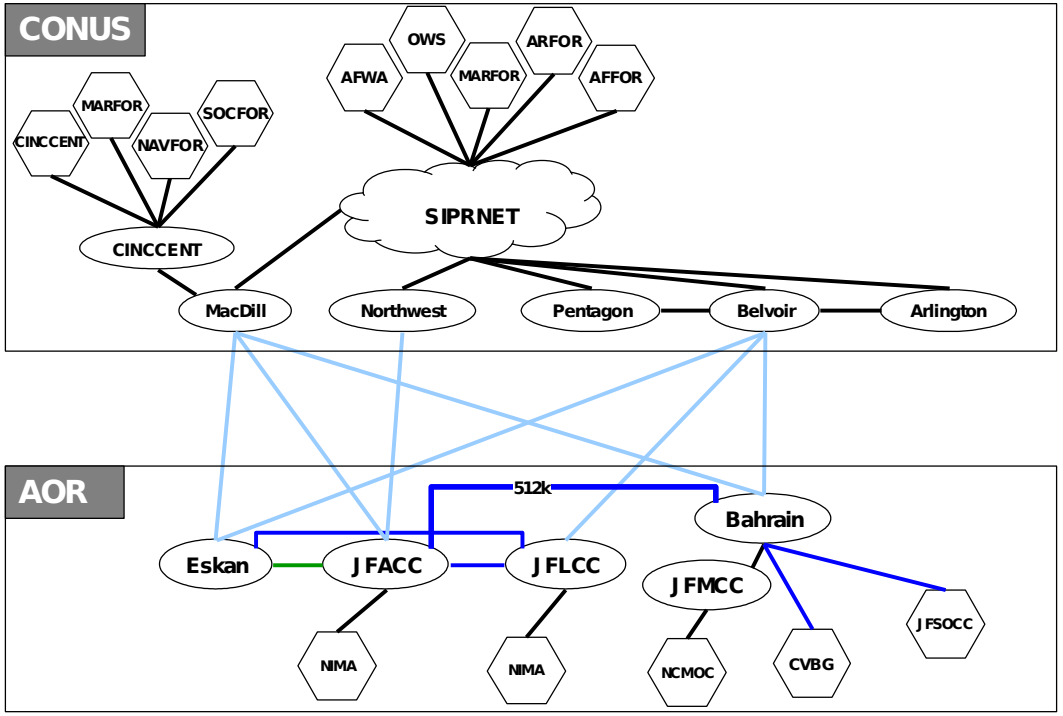
Objective: Validate the use of NETWARS 2001-4 in an operational study

Study Scenario: Evaluate the ability of CENTCOM's intra-theater resources to support time-critical mission applications (GCCS COP, TBMCS, TBMD, I3)

Conclusion: NETWARS is suitable for–

- Evaluating network performance in a complex joint deployment scenario
- Supporting mission effectiveness analyses related to delivery of critical messages
- Quantifying the impact of introducing a new application

within the context of existing libraries



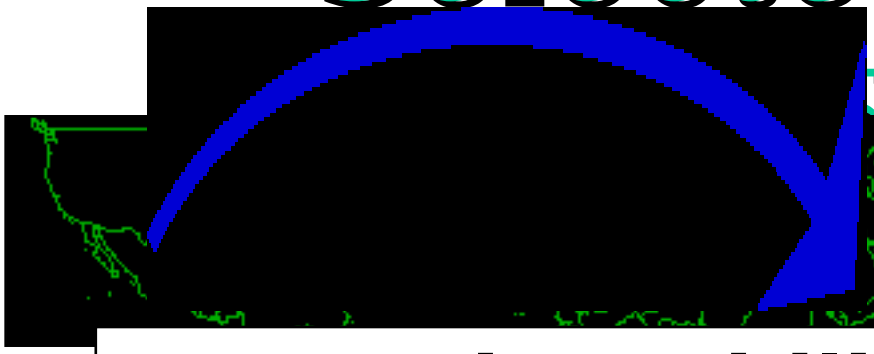
What Is the JICM?

- Worldwide analysis and gaming capability
  - Global OB database
  - World-spanning theater combat coverage
  - Baseline war plans for future warfare
- Integrated simulations and tools
  - Integrated deployment, naval, theater, and nuclear capability in an overall world model
  - Tightly coupled map and graph displays

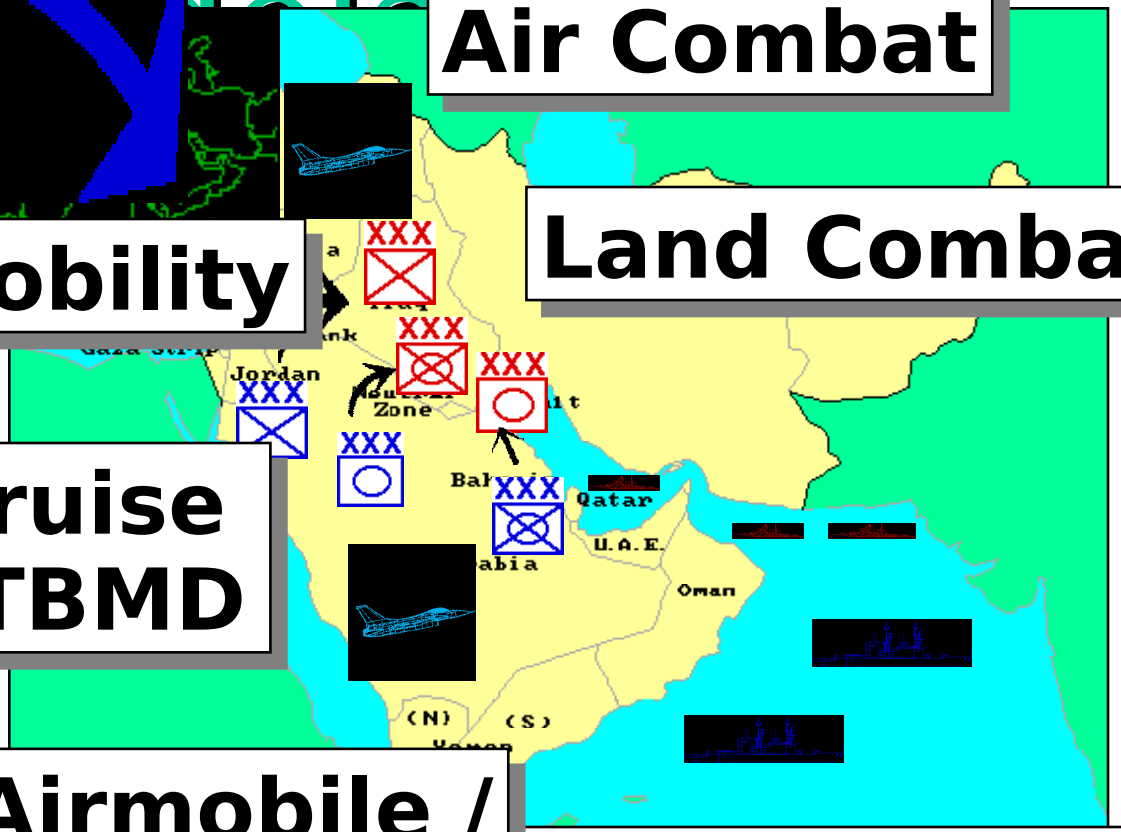
JICM World Perspective

- JICM is a world model
  - Functional models in the JICM environment are integrated by
    - operating in and
    - affecting the state of this world

Selected JICM



Strategic Mobility



Air Combat

Land Comba

Ballistic / Cruise Missiles & TBMD

Amphibious / Airmobile / Airborne Insertions

laval Combat

What Is the JICM?

- Worldwide analysis and gaming capability
  - Global OB database
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